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COMMISSION FOR BASIC SYSTEMS

EXTRAORDINARY SESSION

KARLSRUHE, 30 SEPTEMBER–9 OCTOBER 1998

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REPORTS OF RECENT WMO SESSIONS

Congress and Executive Council

827 — **Twelfth World Meteorological Congress**. Geneva, 30 May–21 June 1995.
829 — **Executive Council**. Forty-seventh session, Geneva, 22–23 June 1995.
846 — **Executive Council.** Forty-eighth session, Geneva, 11–21 June 1996.
867 — **Executive Council**. Forty-ninth session, Geneva, 10–20 June 1997.
880 — **Twelfth World Meteorological Congress**. Proceedings, Geneva, 30 May–21 June 1995.
883 — **Executive Council**. Fiftieth session, Geneva, 16–26 June 1998.

Regional associations

851 — **Regional Association II** (Asia). Eleventh session, Ulaanbaatar, 24 September–3 October 1996.
868 — **Regional Association IV** (North and Central America). Twelfth session, Nassau, 12–21 May 1997.
874 — **Regional Association III** (South America). Twelfth session, Salvador, 17–26 September 1997.
882 — **Regional Association VI** (Europe). Twelfth session, Tel Aviv,18–27 May 1998.
890 — **Regional Association V** (South–West Pacific). Twelfth session, Denpasar, 14–22 September 1998.
891 — **Regional Association I** (Africa). Twelfth session, Arusha, 14–23 October 1998.

Technical commissions

818 — **Commission for Aeronautical Meteorology**. Tenth session, Geneva, 10–21 October 1994.
825 — **Commission for Agricultural Meteorology**. Eleventh session, Havana, 13–24 February 1995.
852 — **Commission for Hydrology**. Tenth session, Koblenz, 2–12 December 1996.
854 — **Commission for Basic Systems**. Eleventh session, Cairo, 28 October–7 November 1996.
860 — C**ommission for Marine Meteorology**. Twelfth session, Havana, 10–20 March 1997.
870 — **Commission for Climatology**. Twelfth session, Geneva, 4–14 August 1997.
879 — **Commission for Atmospheric Sciences**. Twelfth session, Skopje, 23 February–4 March 1998.
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GENERAL SUMMARY OF THE WORK OF THE SESSION

1. **OPENING OF THE SESSION** (agenda item 1)

1.1 The extraordinary session (1998) of the Commission for Basic Systems (CBS) was held in Karlsruhe, Germany from 30 September to 9 October 1998 at the invitation of the Government of Germany. The session, which took place in the Karlsruhe Convention and Exhibition Centre, was opened at 10 a.m. on 30 September 1998 by the president of the Commission, Mr S. Mildner.

1.2 The Secretary-General of the World Meteorological Organization (WMO), Professor G. O. P. Obasi, welcomed the participants to the session on behalf of the Organization. He expressed his pleasure that the session was being held in Germany, and in the historic city of Karlsruhe, in particular, as well as his gratitude to the Government of Germany for its kind invitation, for having provided such fine facilities, and for making all the necessary arrangements for the session. He noted that as Germany was a major participant in the World Weather Watch (WWW) system providing a Regional Telecommunication Hub (RTH) and a Regional Specialized Meteorological Centre (RSMC), it was particularly appropriate to host a session of CBS there. Professor Obasi noted that many political and technological challenges faced the Commission but the primary function of CBS remained the planning and development of the basic systems in support of the WWW. He reminded the participants that in order to continue to serve the needs of the WWW and the other WMO and related international programmes, the basic systems must continue to develop and adapt to meet the changing conditions and changing requirements and to make the best use of new knowledge. The Secretary-General noted that there had been a slow deterioration in the traditional surface and upper-air networks in some regions and that it was therefore critically important that new techniques and technology continued to be developed. He pointed out that the Commission should decide on specific actions and recommendations required for the further implementation and operation of the WWW system. He noted with pleasure that in a relatively short time and with a minimum of resources, the Commission had made substantial progress in the implementation of the Public Weather Services (PWS) Programme. The Secretary-General pointed out that one of the most pressing issues facing WMO Programmes was the year 2000 problem. The Executive Council (EC) had requested the Commission to pursue the year 2000 issue as a matter of high priority with a view to ensuring a sustained and reliable operation of the WWW system.

1.3 Professor Obasi noted that one of the most important issues the Commission would discuss during the session were the proposals for restructuring the mechanisms used to carry out its work. The eleventh session of CBS had agreed to study means to improve the efficiency and effectiveness of the structure of the Commission and its working mechanisms and had envisaged that a period of two years leading up to the present session of the Commission should be used to carry out such a study. He invited the Commission to consider the proposals and to decide on the future structure and working mechanisms of the Commission.

1.4 Mr U. Gärtner, Permanent Representative of Germany with WMO, on behalf of the Deutscher Wetterdienst (DWD) and the Federal Republic of Germany, extended a warm welcome to all participants. He noted that WMO was at a critical point where climate change, natural disasters and other environmental issues were high on the international agenda. He wished the participants a harmonious and successful outcome and noted that he and his staff would do their best to ensure that the meeting ran smoothly and that the participants had a pleasant as well as a productive stay in Karlsruhe.

1.5 On behalf of the State Government of Baden-Württemberg, Ms G. Hämmerle, welcomed the participants and expressed her State's pleasure at hosting such an important WMO meeting. She pointed out the variety of sites and cultural opportunities available within the State and expressed her hope that participants could take advantage of those opportunities during their stay. She noted that the Flood Prediction Centre for the State of Baden-Württemberg had been established in Karlsruhe more than 10 years ago and invited participants to visit the Centre.

1.6 Mr Hans-Jürgen Vogt welcomed the participants on behalf of the City of Karlsruhe. He expressed his pleasure that WMO had chosen to hold that important meeting in Karlsruhe. He noted that meteorology had a long history in Karlsruhe. The university now had an active department of meteorology. He extended a warm welcome and hoped that the participants had an opportunity to see the city during their stay.

1.7 The Secretary-General of WMO presented an outstanding service award to Mr T. Mohr for his long-standing distinguished contributions to WMO. He noted that Mr Mohr had been involved with CBS for more than 25 years, first leading the Working Group on the Global Observing System for 13 years and then serving as the vice-president of the Commission for many years. Mr Mohr expressed his sincere honour and appreciation in accepting the award.

1.8 There were 120 participants at the session which included representatives of 59 Members of WMO and seven international organizations. A complete list of participants is given in Appendix A to this report.

2. **ORGANIZATION OF THE SESSION** (agenda item 2)

2.1 **CONSIDERATION OF THE REPORT ON CREDENTIALS** (agenda item 2.1)

The Commission decided that in accordance with General Regulation 22, it was not necessary to establish a Credentials Committee. The Commission approved the report of the representative of the Secretary-General.

2.2 **ADOPTION OF THE AGENDA** (agenda item 2.2)

The provisional agenda was adopted by the session. The final agenda is reproduced in Appendix B to this report.

2.3 **ESTABLISHMENT OF COMMITTEES** (agenda item 2.3)

2.3.1 One working committee was established to examine the various agenda items in detail. Following proposals by the president, the following chairpersons were appointed for consideration of the individual items:

Ms M. Atkins (United Kingdom) for items 4.1, 4.2, 4.5 and 4.4 (year 2000 problem only);

Mr K. Essendi (Kenya) for items 4.3, 4.6, 4.7, 5 and 9;

Ms A. Simard (Canada) for item 4.4 (except for the year 2000 problem).

Items 6, 7 and 8 would be considered in the Committee of the Whole, chaired by the vice-president, Mr G. Love (Australia), and the remainder of the items would be considered in plenary, chaired by the president.

2.3.2 In accordance with General Regulations 24 and 28, a Coordination Committee was established. It comprised the president and vice-president of the Commission, the representative of the Secretary-General, the chairpersons of the working committee and a representative of the host country.

2.4 **OTHER ORGANIZATIONAL QUESTIONS** (agenda item 2.4)

It was agreed that, with the exception of agenda item 2.1, summarized minutes of the plenary meetings would not need to be prepared. The session agreed upon the working hours for the duration of the session. A complete list of documents presented at the session is contained in Appendix C to this report.

3. **REPORT BY THE PRESIDENT OF THE COMMISSION** (agenda item 3)

3.1 The Commission noted with appreciation the report of the president, Mr S. Mildner (Germany), which provided information on the activities of the Commission since its eleventh session in October/November 1996. It noted with satisfaction that all of its working groups had held full sessions in the period and that a great deal of work had been accomplished. There had been more than 40 meetings during the period on matters falling under the Commission's purview or otherwise related to WWW. Further details of the activities and accomplishments were provided in the reports of the chairpersons of the working groups and discussed under the relevant agenda items.

3.2 The Commission expressed its appreciation for the extensive guidance provided by the two sessions of the Advisory Working Group (AWG), which had kept under review the follow-up to the decisions of CBS, and for the various actions taken by the president especially as regarded the participation of the Commission in the work of other constituent bodies as well as its representation in two sessions of the Executive Council. The Commission noted the various requests for action by the Executive Council, particularly regarding the structure and working arrangements within CBS, the use of Internet and the new WMO practice for the international exchange of data and products, and considered those under the appropriate agenda items.

3.3 In recognizing the substantial progress that had been made, the Commission recognized that a number of major issues and challenges were still before the Commission, as had been indicated by the Executive Council, and should be kept in mind when dealing with the details of its work programme. Among those were:

(*a*) The best use of new telecommunication techniques and protocols for an improved Global Telecommunication System (GTS);

(*b*) The most appropriate use of the Internet for WWW services;

(*c*) The most cost-effective mix of integrated observing systems needed for WMO Programmes;

(*d*) Improved monitoring of the operation of the WWW system;

(*e*) The transfer of knowledge and technology related to PWS.

3.4 Subject to any further directives of the Executive Council, the Commission would also have to keep in mind certain more general policy issues and challenges with which it was faced, namely:

(*a*) Ensuring the wider support of the basic systems to other programmes both within and outside WMO;

(*b*) Applying the important links between meteorology and sustainable development;

(*c*) The needs of developing countries, and those with economies in transition, for support in implementing the basic systems and in building the capacities of regional and national Meteorological Centres (NMCs);

(*d*) Exploiting new technologies with maximum benefit and minimizing any adverse impact for Members and programmes;

(*e*) Contributing to climate monitoring, making the best use of existing networks and avoiding unnecessary duplication;

(*f*) Improving the participation of developing countries in the planning and decision-making process regarding basic systems.

3.5 The president expressed his sincere appreciation to all CBS members who had participated in the activities of the Commission for their enthusiastic cooperation. In particular, he thanked the vice-president, Mr G. Love (Australia), the chairpersons of working groups and study groups and the rapporteurs for their outstanding work, which had made his task so much

easier. On behalf of CBS, the president also thanked the Secretary-General of WMO and the staff of the Secretariat, in particular the WWW Department, for their support and cooperation. He also expressed special appreciation to Mr H. Allard (Canada), who had recently retired from the Atmospheric Environment Service of Canada, for his outstanding contributions to the work of the Commission over many years. Most recently he had served as chairperson of the Working Group on Data Processing as CBS focal point on emergency response activities and as a member of the task team to examine and advise on options for restructuring CBS.

3.6 The president introduced the proposal for restructuring the working arrangements of the Commission and explained the background, goals and objectives of the proposal. Given the general agreement of the Commission with the proposal, an ad hoc group was established to consider it in detail. The group consisted of core members: Messrs Yan Hong (China), E. Mukolwe (Kenya), A. M. Rabiolo (Argentina), J. Jones (United States), G. Love (Australia) and C. Flood (United Kingdom), and any other interested members who wished to participate. The deliberations of the Commission on that issue are recorded under agenda items 7 and 8, as appropriate.

3.7 The Commission noted the contribution of women to meteorology and related fields and adopted Resolution 1 (CBS-Ext.(98)) to further support the achievement of equal opportunity for participation in CBS programmes and activities.

4. WORLD WEATHER WATCH (WWW) COMPONENTS AND SUPPORT FUNCTIONS, INCLUDING REPORTS BY THE CHAIRPERSONS OF WORKING GROUPS (agenda item 4)

4.1 GLOBAL OBSERVING SYSTEM (GOS) (agenda item 4.1)

REPORT OF THE CHAIRPERSON OF THE WORKING GROUP ON OBSERVATIONS

4.1.1 The Commission noted with appreciation the report of the chairperson of the Working Group on Observations, Mr F. S. Zbar (United States).

REVIEW OF OBSERVATIONAL DATA REQUIREMENTS

4.1.2 The Commission was pleased to learn that in order to extend the requirements review process to include the evaluation of *in situ* observing systems, the Working Group on Observations had nominated two experts to work together with experts from the Working Group on Satellites. The continuation of that work would be a part of the future work programme of the Open Programme Area Group (OPAG) on Integrated Observing Systems (IOS).

REPLACEMENT OF OMEGA-BASED UPPER-AIR EQUIPMENT BY ALTERNATIVE SYSTEMS

4.1.3 The Commission recalled that the OMEGA radionavigation system on which 25 per cent of the global upper-air network was dependent had closed down on 30 September 1997. It noted with satisfaction that by that time, CBS and the Commission for Instruments and Methods of Observation (CIMO) had provided the Members concerned with guidance material on possible alternative systems for the replacement of OMEGA-based upper-air equipment. The Task Team on OMEGA-related problems, established by CBS-XI, had identified by February 1997 the most critical areas and had prepared a list of upper-air stations which had been submitted to potential donors for assistance through the Voluntary Cooperation Programme (VCP) to developing countries in upgrading their upper-air stations. The Commission was pleased to note that due to prompt actions taken by the Members concerned, the Secretariat and the donors, dramatic loss of upper-air data was prevented. On the other hand, the Commission felt that that matter should continue to be monitored since at about 50 upper-air stations, OMEGA-based equipment had not been replaced by alternative systems, and some operational difficulties were observed with new Global Positioning System (GPS)-sondes in several parts of the world. In addition to that, the Commission noted with concern that the LORAN-C system was expected to continue to operate through the year 2008 with unknown commitments beyond that period. It also noted that the Russian chain of that system — Chaika — was currently insufficient for operations. The Commission requested that the chairperson of the OPAG on IOS should keep that matter under permanent review and report to the Commission on the progress in that field. The Commission also expressed its concern regarding low availability of upper-air data from some WMO Regions and encouraged Members, in particular potential donors, to provide assistance in improving the current situation.

DEVELOPMENT AND OPERATION OF SPECIALIZED OBSERVING SYSTEMS

4.1.4 The Commission noted the continuing need to keep under review the development and operation of specialized observing systems such as the automated shipboard aerological programme (ASAP), the aircraft meteorological data relay (AMDAR) system, wind-profilers, GPS techniques and their introduction into the GOS.

AUTOMATED SHIPBOARD AEROLOGICAL PROGRAMME (ASAP)

4.1.5 The Commission noted that at present, a total of 24 ships with ASAP units were operated by 10 Members. Upper-air data obtained from ASAP units covered the North Atlantic, the western and central parts of the North Pacific and large areas in the South Atlantic. In 1997, the total number of ASAP soundings slightly decreased (by 4 per cent) relative to 1996, mainly due to the closure of the OMEGA system. However, the small percentage of that decrease clearly showed that most of the operators had performed the transition to GPS-based or other alternative systems in due time. Since ASAP was considered as one important part of the future composite GOS, the Commission was pleased to note that the ASAP Coordinating Committee continued to attract new members interested in operating ASAP units or in providing technical and operational support to new ASAP operators.

AUTOMATED AIRCRAFT OBSERVING AND REPORTING SYSTEMS

4.1.6 The Commission noted the continuing increase in the availability of automated data collected by aircraft-to-satellite data relay (ASDAR) systems and aircraft communication addressing and reporting systems (ACARSs), collectively named AMDAR.

4.1.7 In view of the marked concentration in the data available over Australia, Europe, the North Atlantic and North America, the Commission stressed that attention should be focussed on the data-sparse areas, and in particular, that national Meteorological Services (NMSs) in the developing countries should be able to access in real time the wind and temperature data. The Commission particularly welcomed the initiative by the AMDAR Panel to conduct a pilot project in Southern Africa. It also emphasized that since the potential for expansion of the AMDAR programme was great, there was a need for coordination and cooperation in identifying issues, setting priorities and proposing action programmes. The Commission felt that that issue should be brought before the newly established AMDAR Panel, and with its leading role, an effective international AMDAR programme could make one of the major contributions to the GOS especially in areas where radiosonde networks did not fully meet requirements.

WIND PROFILERS

4.1.8 The Commission was informed on the status of the wind profiler networks in Europe (with the participation of 13 countries), the United States, Australia and Japan. It was pleased to note that a European experiment had been successfully carried out to demonstrate the feasibility of the operational exchange of wind-profiler measurements in the BUFR code, and that a permanent assignment of 449 MHz had been made for United States operational profilers. Although the wind profilers were not fully operational in large numbers, they were extremely useful as supplementary systems in providing data of high resolution in time and space between balloon-borne soundings and had great potential as a part of integrated networks. The Commission felt every encouragement should be given to Members to achieve a more widespread deployment and operational use of wind profilers, recognizing that national radio frequency assignment in certain Member countries was not resolved.

GLOBAL POSITIONING SYSTEM (GPS) TECHNIQUES

4.1.9 The Commission noted with interest that there were some developments in Europe, Japan and the United States regarding the measurements of total atmosphere water vapour content or integrated precipitable water using GPS signals in combination with low-cost ground-based receivers (GPS-IPW), and also the measurement of profiles of the refractivity index of the atmosphere, enabling the derivation of moisture or temperature through satellite occultation techniques (GPS-Met). A new European project, European Cooperation in the Field of Scientific and Technical Research (COST), had been set up to examine those techniques. The Commission was pleased to know that in order to keep abreast of developments in that regard and to evaluate those techniques from the point of view of the cost of alternative systems, data quality and real-time data acquisition, the working group had appointed a Rapporteur on GPS Techniques to work in close contact with the corresponding CIMO Rapporteur.

REDESIGN OF THE GLOBAL OBSERVING SYSTEM (GOS)

4.1.10 In light of the critical situation that had developed in the implementation of upper-air networks due to economic difficulties experienced by many developing countries and countries with economies in transition, CBS-XI had called for a number of actions to address the issue. The Commission noted with satisfaction that as part of the follow-up action, WMO had sponsored a workshop organized by the Coordinating Group for the Composite Observing System for the North Atlantic (COSNA) (CGC) on the Impact of Observing Systems on Numerical Forecasts (Geneva, 7–9 April 1997) and had also convened an Expert Meeting on the Future Composite Global Upper-air Network (Geneva, 29 April–2 May 1997).

4.1.11 The Commission recognized the importance of making modifications to the observing network based upon the results of impact studies already undertaken or to be undertaken at various numerical weather prediction (NWP) centres that had appropriate assimilation and model facilities. While activities were now under way in North America and Europe in that regard, the Commission stressed the need for a coordinated global approach, involving experts and decision makers in observing technology, network design, data assimilation techniques and NWP, and for a possible new joint funding mechanisms for the deployment of observations in remote and/or extraterritorial areas. It also expressed a view that in carrying out impact studies, efforts should be made to select "worst case" situations to test the impact of different mixes of observing systems as well as generalized statistics gathered over extended representative periods.

4.1.12 The Commission also noted that the forty-ninth session of the Executive Council had confirmed the need for a coordinated global approach to achieve what would be a fundamental redesign of the GOS and had requested CBS to continue vigorously its efforts in that regard. Taking into account the views of the forty-ninth session of the Executive Council, the Working Group on Observations, at its seventh session, had recommended that a task team on the future composite GOS be established.

4.1.13 In considering that issue, the Commission noted that Members had a great interest in optimizing their investment in observing systems and that advancing scientific knowledge and technology were providing many opportunities for increasing the availability of observational data while reducing costs (see also general summary paragraph 4.1.20). It was recognized, however, that the task of establishing an optimum composite observing system required access to

scientific and technical resources, which were normally made available within national and regional studies to assist in local decision making. In the light of the above, the Commission decided to establish a mechanism to build upon such studies, to further broaden and extend their findings to the global scale and to promote the use of the results in investment decisions of Members. The Commission recorded its decision under agenda item 8.

INTERRELATION BETWEEN THE GLOBAL OBSERVING SYSTEM (GOS) AND THE GLOBAL CLIMATE OBSERVING SYSTEM (GCOS)

4.1.14 The Commission recalled that the Working Group on Observations had provided a substantial contribution to the design and selection of upper-air and surface stations to the GCOS upper-air network (GUAN) and the GCOS surface network (GSN). It noted with appreciation that following the request of CBS-XI, the European Centre for Medium-range Weather Forecasts (ECMWF), as lead centre for monitoring the quality of upper-air data, had provided the GCOS Bureau with three six-monthly reports on the availability and quality of data from GUAN stations covering the period from 1 January 1997 to 31 July 1998. The Commission expressed concern that according to those reports, about 20 per cent of GUAN stations could not be used at their current performance levels due to low availability of data and large random deviation/bias. The Commission supported the recommendation of the fourth session of the GCOS/WCRP Atmospheric Observation Panel on Climate (AOPC-IV, Hawaii, United States, April 1998) that the Secretary-General send a letter to the Members concerned requesting them to take action in order to rehabilitate the silent stations and improve the quality of observations at suspect stations.

4.1.15 As regarded GSN, the Commission was informed that a list containing about 1 000 surface stations selected by the CBS/Commission for Climatology (CCl) Group of Experts had been sent to the Members concerned requesting them to consider the practicability of implementation and the possibility of their undertaking long-term commitments to maintaining and operating the selected stations. After revision and replacement of some stations, most of the Members concerned had agreed with the inclusion of their stations in the GSN. The final lists of GSN and GUAN stations in each region were recently sent to the presidents of the regional associations (RAs) for formal approval as contributions to global networks. Approved lists of the GSN and GUAN stations should then be sent to the Members concerned with a request to implement observing programmes at those stations according to best practices. The Commission noted with appreciation that sets of recommended best practices for GSN and GUAN stations were developed by the working group (see also general summary paragraph 4.1.18).

4.1.16 The Commission noted that monitoring the availability and quality of data from GSN stations would be carried out by Climate Centres in Germany and Japan as offered by those countries at CCl-XII. It further noted that the World Data Centres (WDCs) A and B for meteorological data (National Climatic Data Center (NCDC) Asheville, United States and Obninsk, Russian Federation) would be the most appropriate locations for central repositories of CLIMAT messages transmitted over the GTS, historical climate data and associated metadata. The Commission agreed that monitoring the operation of GSN stations in each region would be carried out by CBS in collaboration with regional working groups on the WWW.

4.1.17 The Commission noted with appreciation the report of the chairperson of the GCOS/World Climate Research Programme (WCRP) Atmospheric Observation Panel for Climate (AOPC), Mr M. Manton (Australia), on the recent activities within the GCOS Programme. It also noted that following Recommendation 1 (CBS-Ext.(94)) — CBS contribution to the Global Climate Observing System, the CBS working groups had significantly contributed to the work of the GCOS panels, in particular regarding the coordination of observational data requirements, the design and implementation of the GCOS Initial Operational System on the basis of the WWW, and the development of a data management plan for GCOS sites. The Commission encouraged Members to strive to meet the best practices guidelines for GSN and GUAN stations and to provide historical daily data at GSN and GUAN sites for the analysis of climate indicators for the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC).

***MANUAL ON THE GLOBAL OBSERVING SYSTEM (GOS)* (WMO-NO. 544)**

4.1.18 The Commission reviewed and endorsed the proposed amendments to Volume I, Part III of the M*anual on the Global Observing System*, which included the sets of recommended best practices for GSN and GUAN stations. Recommendation 1 (CBS-Ext.(98)) was adopted.

4.1.19 The Commission was informed that the CBS Advisory Working Group, at its twenty-first session, had noted that the M*anual on the Global Observing System* often referred to the *Manual on Codes* (WMO-No. 306) for detailed regulations. It also noted that the new sixth edition of the *Guide to Meteorological Instruments and Methods of Observations* (WMO-No. 8) contained many recommendations on observing practices and that several more could be found in the *Guide to Climatological Practices* (WMO-No. 100). The Commission recommended to the OPAG on Integrated Observing Systems to collect all the observing practices described in various WMO *Manuals* other than the M*anual on the Global Observing System*, to study their relevance, to assess the new requirements and to prepare a revised version of the *Manual on the Global Observing System*.

CBS TECHNICAL CONFERENCE ON INTEGRATED UPPER-AIR OBSERVING (28–29 SEPTEMBER 1998)

4.1.20 The Commission expressed its appreciation for the convening of the Technical Conference on Integrated Upper-Air Observing, which was held over a

two-day period in conjunction with its extraordinary session. It specifically placed its appreciation on record for the excellent preparatory work and organization by the president of the Commission, the CBS Advisory Working Group as the organizing committee, the Conference Director, Mr J. Rasmussen (United States), and the Secretariat. It also expressed special thanks to the session chairpersons and the 13 lecturers for the high quality of their presentations, which had generated lively discussions during the final Conference session. The Commission reviewed and endorsed the statement of the Technical Conference including the recommended actions as given in Annex I to this report. It recorded its deliberations relating to the recommended actions under the appropriate agenda items.

FUTURE WORK PROGRAMME

4.1.21 The Commission agreed on the future work as given under agenda item 8.

4.2 **GLOBAL TELECOMMUNICATION SYSTEM (GTS)** (agenda item 4.2)

4.2.1 The Commission noted with appreciation the report of the chairperson of the Working Group on Telecommunications (WG-TEL), Mr M. Fischer (France), including the work accomplished by the fourteenth session of the working group and other related meetings.

4.2.2 The Commission noted that the WG-TEL considered and generally supported the draft proposal for reorganizing the working structure of the Commission. It considered the views expressed by the working group in that respect.

STATUS OF IMPLEMENTATION AND OPERATION OF THE GTS

MAIN TELECOMMUNICATION NETWORK (MTN) AND REGIONAL METEOROLOGICAL TELECOMMUNICATION NETWORKS (RMTNS)

4.2.3 All 23 MTN circuits were in operation and all MTN centres were automated. Seven out of 23 circuits were using digital technology at speeds from 64 to 128 kbit/s. Except the telegraphic circuit New Delhi-Cairo (100 Baud), the other MTN circuits were operating at data rate greater than 4.8 kbit/s. All but one of the MTN circuits currently used X.25 protocol and a few centres were supporting passage of non-adjacent traffic. The Commission also noted that several MTN centres had firm plans for the introduction or further implementation of Transmission Control Protocol/Internet Protocol (TCP/IP) procedures on MTN circuits and other GTS circuits, as well as for their national meteorological telecommunication networks.

4.2.4 The Commission noted the status of implementation of RMTNs. Significant progress was made concerning the interconnection between RMTNs and the MTN, but serious shortcomings still existed in some regions at regional and national levels. In Region I, the development of subregional networks, such as the very small aperture terminal (VSAT) network coordinated by the Agency for Air Safety in Africa and Madagascar (ASECNA) in the western and central parts of Africa and the planned Southern African Development Community (SADC) network in the southern part, appeared to provide promising solutions for upgrading the RMTN. The collection of observational data remained unsatisfactory (less than 50 per cent) due to national difficulties in the implementation and maintenance of equipment. Telecommunication services were normally available from the PTTs, but at costs not affordable by several national Meteorological and Hydrological Services (NMHSs). The data collection system/data collection platforms (DCS/DCPs) via METEOSAT offered the potential for a considerable improvement of data collection in the Region. The observational data-collection system in Region II was in general quite satisfactory, except in a few countries where serious shortcomings still existed. New solutions based on satellite-based telecommunications and managed data-communication network services were being explored to upgrade the RMTN. A pilot project was developed for improving the dissemination of meteorological data and products via the United Kingdom satellite facilities (UKSF), which also supported the satellite distribution system (SADIS). The Commission was informed by the United Kingdom that technical difficulties, which were expected to be solved very soon, had delayed the pilot project.

4.2.5 Region III was developing a project to upgrade the RMTN, which mainly consisted of low-speed point-to-point circuits, by a new network, based on manage data-communication network services. A satellite-based data-distribution system was operated by RTH Buenos Aires. All 13 NMCs were also equipped with world area forecast system (WAFS) receiving systems via the international satellite communications system (ISCS) operated by the United States. In Region IV, the two-way satellite-based network RMTN was fully operational in all countries concerned (except Haiti). The local integration of the associated computer-based systems into the NMCs was an ongoing activity to take the best operational benefit.

4.2.6 In Region V the RMTN comprised most circuits operating at medium or high speed, but the links to small nations in the Pacific were extremely difficult to implement. The ISCS operated by the United States was being implemented to support the WAFS distribution, and its GTS component was recommended for integration into the RMTN. The DCS of the geostationary meteorological satellite (GMS) and the geostationary operational environmental satellite (GOES), the GOES emergency managers weather information network (EMWIN), the INMARSAT system, as well as public data-communication networks and/or the Internet were operated or planned for improving the RMTN.

4.2.7 In Region VI, the major effort had been directed towards establishing the regional meteorological data communication network (RMDCN). The RMDCN would be implemented by using a shared, commercially-provided managed network service to which NMCs and RTHs would be connected via a national access, replacing all current point-to-point circuits. The RMDCN

would meet RA VI GTS requirements as well as data exchange requirements between ECMWF and its Member States and Cooperating States.

MULTIPOINT TELECOMMUNICATION SERVICES VIA SATELLITE AND RADIO BROADCASTS

4.2.8 The Commission noted the extensive implementation of satellite-based multipoint telecommunications systems. As shown in Annex II to this report, each WMO Region was completely covered by at least one satellite distribution system. The Commission underlined that coordination mechanisms should be developed to ensure that the requirements of the user WWW centres were met to the largest extent possible. It noted that coordination mechanisms already existed for Region I with respect to the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)/ meteorological data distribution ((MDD) and in Region IV for the satellite-based RMTN. The Commission agreed on the necessity to rationalize the use of those systems, and recommended that:

(*a*) The satellite distribution systems should be associated to an identified group of user countries; the countries of such a group might belong to different Regions;

(*b*) A coordination mechanism should be developed to ensure the representation of the associated group of user countries in the review of the programme of transmission of each corresponding satellite distribution system. Coordination entities should mainly work by correspondence (e.g. e-mail).

4.2.9 NMHSs should be able to access information related to the programme of transmission of satellite distribution systems. The information was required for assessing the impact of the implementation of a new receiving system, or for taking the best benefit from an existing system. The Commission recommended that:

(*a*) Each operator of a satellite distribution system send a summary of the programme of transmission to the WMO Secretariat, for insertion into *Weather Reporting* (WMO-No. 9), Volume C2;

(*b*) Each RTH operating a satellite distribution system(s) should include its satellite distribution system(s) into its routeing catalogue to identify the abbreviated headings of all the bulletins distributed via its satellite distribution system(s);

(*c*) For RTHs and NMCs which could not access File Transfer Protocol (FTP) servers, routeing catalogues should be provided by the relevant RTHs on magnetic media (e.g. diskette), upon request addressed to the RTH focal point.

4.2.10 Several Members already discontinued the operation of high frequency (HF) broadcasts, which had high recurrent operational costs and a limited efficiency, in some instances replacing them by satellite distribution systems. The Commission noted that there might still be requirements to continue HF broadcasts in some areas, and stressed the importance of assessing at the regional level the remaining requirements and the importance of considering alternative means to satisfy those requirements. It noted that the maritime community (ships) still had requirements to receive products by HF broadcasts. The Commission felt that alternative means, like the use of INMARSAT distribution systems within the framework of the Global Maritime Distress and Safety System (GMDSS) or the access to data bases, should be considered to distribute products to ships. It felt that the Commission for Marine Meteorology (CMM) was in the best position to determine the requirements of the maritime community in that respect and to identify the most appropriate systems to meet them.

MONITORING ACTIVITIES

ANNUAL GLOBAL MONITORING (AGM)

4.2.11 About 100 WWW centres were providing information on the availability of observational data for the AGM of the WWW, which provided an overall assessment of WWW operations. The results of the AGM analysis were distributed to Members and the detailed files were available on the WMO FTP server.

SPECIAL MTN MONITORING (SMM)

4.2.12 Three SMM exercises were carried out in 1998, and the Commission agreed that the SMM was very instrumental in identifying deficiencies in the operation of the GTS. It was pleased to note that the discrepancies in the availability of data at the participating centres had been reduced progressively during the successive SMM exercises. Files containing the SMM data and the results of their analysis were available on the WMO FTP server. It invited all RTHs to analyse further the SMM data and results and to liaise with their associated NMCs with a view to mitigating deficiencies. It also noted that there was no MTN centre located in Regions III, IV and V, which were participating in the SMM, and invited the centres in those respective Regions to join.

4.2.13 The current periods for the SMM exercises were 1–15 April, 1–15 July and 1–15 October. The evaluation of the operation of the WWW during periods of specific interest, such as the cyclone season in the southwest Indian Ocean or the summer season in Antarctica, was not possible. The Commission therefore agreed that an SMM exercise also be carried out each year from 1 to 15 February, at the same time as the specific monitoring on the exchange of Antarctic meteorological data.

OPERATIONAL MATTERS

FORMAT OF METEOROLOGICAL MESSAGES

4.2.14 The Commission agreed that the existing limit of 3 800 octets on alphanumeric messages should be increased to 15 000 octets on 6 November 2000, and it urged GTS centres to make the necessary implementation changes in due time. It also agreed that sets of information, which exceeded 250 000 octets, should not be transmitted using segmentation into a series of bulletins, but should rather use the file transfer technique.

4.2.15 The Commission recalled that abbreviated headings for bulletins related to volcanic ash and tropical cyclones were allocated to satisfy the International Civil Aviation Organization (ICAO) requirements. However, it noted that, in some instances, GTS centres received related bulletins with incorrect abbreviated headings, which hampered their relay on the GTS. The Commission requested the centres generating those bulletins to ensure that correct abbreviated headings were used, and invited the Commission for Aeronautical Meteorology (CAeM) to take any further action required.

EXCHANGE OF ADDRESSED MESSAGES

4.2.16 The Commission noted that two specific monitoring exercises on the exchange of addressed messages on the MTN were carried out. The results showed that the exchange of the addressed messages was not fully satisfactory and a detailed MTN routeing map for addressed messages was being prepared.

ROUTEING CATALOGUES

4.2.17 The Commission noted with appreciation that an increasing number of RTHs were providing their routeing catalogue on diskette, on their FTP server or via the WMO FTP server. RTH Offenbach implemented a mirror of the WMO FTP server for the routeing catalogues, with a view to ensuring a 24 hour-a-day access. The Commission re-emphasized the importance of routeing catalogues for ensuring and monitoring the consistent and efficient GTS data exchange, and for informing NMCs of the bulletins available at RTHs. It agreed that the procedures and format for the provision of routeing catalogues should be included in the *Manual on the Global Telecommumication System* (WMO-No. 386). The Commission noted that a more stringent plan for the routeing of data over the MTN, at least for observational data, was under development to overcome present discrepancies.

CATALOGUE OF METEOROLOGICAL BULLETINS

4.2.18 The Commission noted with appreciation and endorsed the detailed format and procedures for updating the Catalogue of Meteorological Bulletins as a database, which were developed by the WG-TEL and tested by two RTHs, as a follow-up to CBS-XI conclusions and requests. The format and procedures are described in Annex III to this report. World Meteorological Centres (WMCs)/RTHs on the MTN took the responsibility of updating the part of the catalogue as regarded bulletins issued from the zone for which they were responsible for the collection, exchange and distribution of data, and also of including data from the Antarctica as appropriate. The Commission agreed to include that new task in the list of functions and responsibilities of WMCs/RTHs given in the *Manual on the Global Telecommumication System* (WMO-No. 386). The WMCs/RTHs' involvement would ensure that the catalogue was an operational document which provided adequate information on the bulletins actually exchanged (or required for exchange) on the GTS.

4.2.19 MTN centres should provide the relevant catalogue information on their FTP server and notify changes via FTP to the WMO Secretariat, which maintained the comprehensive catalogue on its FTP server. The Commission thanked Germany for its offer to implement and operate at RTH Offenbach a mirror site of the WMO FTP server for the Catalogue of Meteorological Bulletins, with a view to ensuring a full operational service. Noting that the implementation of the required arrangements at MTN centres and the Secretariat would be progressive, the Commission invited Members concerned to start implementation as from 1 March 1999.

REGIONAL TELECOMMUNICATION HUB (RTH) FOCAL POINTS

4.2.20 The Commission noted that almost all RTHs had designated a focal point and that it had greatly facilitated the coordination of the GTS operation.

TELECOMMUNICATION TECHNIQUES AND PROTOCOLS

TELECOMMUNICATION TECHNIQUES AND SERVICES

4.2.21 The Commission agreed upon a revision of the technical characteristics and specifications for the GTS contained in the *Manual on the Global Telecommumication System* (WMO-No. 386), Volume I, Part III, with a view to benefiting from new telecommunication means, services and techniques such as frame relay services, managed network services, digital leased circuits as well as recent Internatiional Telecommunications Union (ITU)-T recommendations for modems.

ITU-T X.25 PROCEDURES

4.2.22 The Commission endorsed procedures for the use of X.25 virtual calls (VCs), also called switched virtual circuits (SVCs), on GTS circuits. It agreed that, with the transition to the use of TCP/IP, there was no need for the further development of X.25 procedures for the GTS.

USE OF THE TRANSMISSION CONTROL PROTOCOL/INTERNET PROTOCOL (TCP/IP)

4.2.23 The Commission expressed its appreciation for the accomplishments made since its last session, especially for the development of practices and procedures for the use of TCP/IP on the GTS. It fully concurred that the TCP/IP protocols should replace X.25 for supporting GTS operations in the future. The transition to TCP/IP was considered appropriate because:

(*a*) Vendor support for X.25 technology was declining and becoming more expensive due to industry concentration on TCP/IP;

(*b*) Vendor support for TCP/IP was widely available and was included in the whole range of hardware/firmware platforms;

(*c*) TCP/IP was supporting numerous application utilities available off the shelf, which offered solutions to information communication needs of Members, such as file transfer, electronic mail and other applications;

(*d*) TCP/IP provided connectivity between Members in a more flexible and versatile manner than the X.25-based equivalent.

4.2.24 The Commission felt that those benefits equated to direct savings in financial and human resource to Members by reduced costs for communications equipment purchase and maintenance, as well as by reduced software development work through use of industry standard software systems. It underlined, however, that other aspects — such as the administration of the system, which was more complex and could involve issues outside of the meteorological community (e.g. IP addressing and network security) — would involve some hidden costs. The Commission particularly emphasized the need for strong security measures and equipment (firewall, systems configuration) to protect the GTS from the Internet when the two coexisted, and requested its working group to develop guidance in that respect. The Commission agreed that the introduction of TCP/IP on the GTS would be progressive, taking into account the capabilities of various NMHSs, and noted the implementation arrangements for the orderly transition from the X.25-based GTS.

4.2.25 The Commission underlined that TCP/IP procedures for the GTS were defined to ensure that the primary function of the GTS in carrying real-time operational traffic with minimum delay was preserved. It noted the arrangements for the allocation of IP addresses, which should be closely coordinated by the WMO Secretariat, and expressed its appreciation and thanks for the Class C IP addresses provided by *Météo-France* for the benefit of the whole GTS community. It confirmed that those IP addresses should only be used for GTS circuits and should not be advertised on the Internet due to security reasons.

4.2.26 The Commission re-affirmed the importance of adopting standard data-communication protocols and applications for the GTS to the largest extent possible, thus dramatically improving the cost effectiveness of GTS facilities and systems. It agreed that special procedures should only be developed and implemented to facilitate transition implementation or to cope with very specific requirements or constraints. It noted in that respect that the TCP "socket" procedure was adopted with a view to facilitating the introduction of TCP/IP with message switching system (MSS) facilities, but comprehensive and consistent suites of protocols, such as the FTP, were considered as the long-term solution for the GTS. It also noted that the WG-TEL considered a special TCP "socket"-based procedure for use on low-quality telephone type circuits, which had been successfully implemented by some Members.

4.2.27 A file-naming procedure, consisting in a cyclic numbering scheme, was included for meeting FTP requirements on the GTS. The file-naming procedure for new sets of information (i.e. not in the form of GTS bulletins) was based on transmission of file pairs, one file being the information file and the other being the associated metadata file. The urgent need for file-naming conventions and metadata standards was stressed in that respect.

4.2.28 The Commission agreed on the amendments to the *Manual on the Global Telecommumication System* (WMO-No. 386), Volume I, Part II, addressing the introduction of TCP/IP on the GTS, including the new Attachment II-15 on the use of TCP/IP on the GTS. Members were strongly advised to take account of the adoption of the TCP/IP-based strategy for the future development of the GTS in planning the future development of systems within their national centres.

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUMICATION SYSTEM* (WMO-NO. 386), VOLUME I, GLOBAL ASPECTS

4.2.29 With regard to the conclusions reflected above, the Commission adopted Recommendation 2 (CBS-Ext.(98)) concerning amendments to the *Manual on the Global Telecommumication System* (WMO-No. 386), Volume I, Parts I, II and III.

STRUCTURE OF THE MAIN TELECOMMUNICATION NETWORK (MTN)

4.2.30 The Commission emphasized that the GTS, and in particular the MTN which supported and interconnected the regional networks, had been the key basis for the cooperation of all NMSs, and a fundamental element for the WMO itself. The MTN development should keep up with the challenge of the changing requirements and capabilities. The Commission agreed that it was the appropriate time for a fundamental review of the MTN structure, in view of the evolving data exchange requirements (of WWW and other WMO Programmes). The development of new telecommunication means and services made it possible to improve dramatically the cost-efficiency of the MTN as a genuine network.

4.2.31 The Commission noted that the relative homogeneity of RTHs on the MTN should facilitate the development and implementation of an improved MTN. It emphasized the crucial importance of the interface which was provided by RTHs on the MTN between the MTN and the respective RMTNs. It also felt that the most difficult area for such a project would be of an administrative nature, with respect to procurement, contractual arrangements, cost-sharing arrangements, operational control and monitoring, etc.

4.2.32 The Commission agreed that a mechanism should be established as a matter of high priority for developing and consolidating an improved MTN project. The project would include the following elements:

(*a*) The various types of applications to be supported by the improved MTN, including current GTS applications (e.g. data collection and distribution of data and products) as well as new emerging applications (e.g. operational distributed databases (DDBs), servers of operational data, file transfer), and the impact on the GTS structure;

(*b*) The data transport network required to support the MTN;

(*c*) The functions and responsibilities of MTN centres;

(*d*) The interfaces and gateways between the MTN and RMTNs, ensuring an efficient operation of the GTS as a whole;

(*e*) The administrative aspects of the development and implementation of the project.

4.2.33 The Commission noted that some elements of the project, among those listed above, would likely require the establishment of ad hoc teams for the further development of the project. The importance of the project and the considerable amount of work to be carried out required that the experts involved in the project would need to invest adequate time and resources. That investment of efforts would result in an improved cost-efficiency of the MTN and eventually the whole GTS, thus resulting in a considerable benefit for all NMHSs.

4.2.34 It was expected that a consolidated proposal would be developed to ensure that CBS-XII (2000) could be in a position to take firm decisions for the further development and implementation of the project. A realistic target for the actual operational implementation of the improved MTN might be the year 2002. It noted, as a tentative possible plan, the following working schedule:

(*a*) Development of a project, including an outline of the technical specifications for the invitation to tender and draft administrative and financial arrangements, in 1999–2000. The draft project would be submitted for agreement to Members expected to be involved in its implementation and operation;

(*b*) Presentation of the draft project to the Executive Council in the year 2000 for comments and guidance;

(*c*) Finalization and approval of that project by CBS-XII (2000), taking into account the comments made by the Executive Council. Designation of one or more operational and administrative responsible entities. Setting up of the Contracts Advisory Committee;

(*d*) Preparation by the responsible body of the invitation to tender in the first half of 2001;

(*e*) Final approval by the Executive Council in June 2001 and launch of the invitation to tender in the second half of 2001;

(*f*) Concluding formal contractual and financial arrangements and bringing the new MTN network into operation in the year 2002.

ADMINISTRATIVE AND FINANCIAL GUIDELINES FOR GTS IMPLEMENTATION

4.2.35 Noting the current arrangements between WMO Members for funding the various GTS components, the Commission encouraged Members to investigate the opportunities, within their own countries and in partnership with other Members, for taking advantage of the increasingly competitive market for telecommunication services. It also agreed that the cost-effectiveness aspects, including equitable sharing of costs among beneficiaries, should be an essential element of the GTS modernization strategy.

IMPLEMENTATION COORDINATION AND SUPPORT ACTIVITIES, INCLUDING TRAINING

4.2.36 While noting with appreciation the training seminars and workshops on telecommunications, which were efficiently organized within the limited budgetary resources, the Commission stressed the importance of training activities, as a prerequisite for facilitating the introduction of modern and efficient telecommunications techniques into the GTS, in particular for developing countries. The Commission also noted that the adoption of industry standards for the GTS, such as TCP/IP, was providing better opportunities for the sustainable introduction of computer-based GTS/Global Data-processing System (GDPS) in many NMCs.

FUTURE WORK PROGRAMME

4.2.37 The Commission agreed on the work programme, which was taken into account in the CBS working programme and structure (see agenda items 7 and 8, respectively).

RADIO FREQUENCIES FOR METEOROLOGICAL ACTIVITIES

4.2.38 The Commission noted that the 1997 World Radio-communication Conference (WRC-97, Geneva, October/November 1997) had considered several items of concern for meteorology and had not reduced existing radio frequency allocations to meteorological aids and meteorological satellites. WRC-97 had also decided on new regulatory provisions to meet most frequency requirements for meteorological and Earth-exploration satellites, including space borne remote sensing, and for wind profiler radars. The active participation of WMO, including NMHSs' experts and the WMO Secretariat, was instrumental in ensuring that meteorological issues had been recognized and supported at WRC-97. The Commission expressed its appreciation for the effective coordination activities undertaken by the Steering Group on Radio Frequency Coordination (SG-RFC) and the Secretariat, and in particular the guidance and background information on WRC-97 issues which was provided to Members. The Commission recalled that the Steering Group had been established by Resolution 10 (CBS-97), in replacement of the former Subgroup of the WG-TEL. In view of its increasing visibility and recognition, both within the meteorological community and outside, in particular in ITU forums, the Commission agreed to maintain the Steering Group on Radio Frequency Coordination in its new structure.

4.2.39 The main decisions of WRC-97 of relevance to meteorological activities were summarized as follows:

(*a*) Upgrade of the allocation to the meteorological satellite (Met-Sat) and Earth-exploration satellite (EES) services (DCPs) in the 401–403 MHz band to primary status. WMO would have to undertake coordination of the frequency use in the 401–403 MHz band between the meteorological aids (Met-Aids), Met-Sat and EES services;

(*b*) Reallocation of the non-geostationary Met-Sat in the 7 750–7 850 MHz band, for ensuring continued viable operation of the polar-orbiting meteorological satellite systems. The allocation of the 7 450–7 550 MHz band to geostationary Met-Sat had been maintained;

(*c*) Changes of allocations to the passive Earth-exploration satellite, space research (SR) services, and fixed, mobile and inter-satellite services within the 50–60 GHz band for ensuring satisfactory operation

of spaceborne passive remote sensing in the oxygen absorption band;

(*d*) Regulatory provisions, including a resolution, for the operation of wind profiler radars as radiolocation-service systems in the 46–68 MHz, 440–450 MHz, 470–494 MHz (alternatively 420–435 MHz or 438–440 MHz), 904–928 MHz (in ITU Region 2), 1 270–1 295 MHz and 1 300–1 375 MHz bands;

(*e*) Upgrade of the allocation to space-based active sensors (EES and SR services) in various bands between 1 and 25 GHz to primary status. Space-based active sensors provided data of importance for several meteorological applications;

(*f*) Upgrade of the allocation to EES services (space-to-Earth data transfer) in the 25.5–27.0 GHz band to primary status.

The Commission noted with appreciation that the SG-RFC, following-up those decisions, was planning to develop guidance material for NMHS with respect to the coordination of radiosondes and DCPs in the 401–403 MHz band, and national assignment of frequencies for operation of wind profiler radars (in coordination with the European Cooperation in the Field of Scientific and Technical Research (COST) Project 76).

4.2.40 The Commission noted with concern, however, that the threat to the radio frequency bands allocated to Met-Aids (radiosondes) and Met-Sat would continue at least until the next WRC (2000). The development of new systems (low-Earth orbiting satellites (LEOs) of the mobile satellite service (MSS) was exerting pressure for new frequency allocation to MSS below 3 GHz, including part of the 401-406 MHz band for "little LEOs" and of the 1 675–1 690 MHz band for "big LEOs". The Commission noted with particular concern that WRC-97 had urged ITU Member countries and had requested ITU-R (Radiocommunication Study Group 7), with the participation of WMO, to assess the current and future spectrum requirements for Met-aids in the 401–406 MHz band, with a view to a possible removal out of the 405–406 MHz band.

4.2.41 The Commission stressed that a reduction of bands allocated to Met-Aids would need more spectrum-efficient radiosondes (frequency stability, narrow-band) and would increase significantly the operational costs of radiosonde networks. In view of the considerable difficulties already experienced by many Members, in particular developing countries, in meeting upper-air observation requirements, any cost increase would have a detrimental impact on meteorological operations. It also noted that the development of Met-Sat DCP operations in the 401–403 MHz band, facilitated by its primary status allocation, could also be expected to limit radiosonde use in that band. The Commission also stressed that radiosonde requirements included several applications beyond the control of most NMHSs (e.g. defence, environment/pollution, emergency response, research, etc.), which were rapidly increasing and should be taken into due account.

4.2.42 The Commission urged Members to participate in the above-mentioned ITU-R studies, to coordinate their contribution with their national telecommunication administration with a view to emphasizing meteorological requirements, and to participate actively in related national radio frequency management activities. The Commission emphasized the importance and impact of the preparatory activities on WRC issues conducted by regional radio frequency management organizations, such as the European Conference of Postal and Telecommunications Administrations (CEPT) for Europe, the Asian-Pacific Telecommunity (APT) for Asia-Pacific and the Inter-American Telecommunications Commission (CITEL) for the Americas. The Commission requested the Secretary-General to invite a few Members concerned and interested, from each area, to agree to take the responsibility of ensuring an adequate expert participation, on behalf of WMO, in the meetings of the relevant groups of the respective regional organization dealing with WRC issues of concern for meteorology.

4.2.43 Considerable efforts had already been made in defining the current status and trends for radiocommunication characteristics of radiosondes and in assessing frequency requirements in support to ITU-R activities and in preparation to WRC-97. The Commission however agreed that, in view of the importance of the issue, further coordination efforts should be made, and requested the Secretary-General to organize an expert meeting on radiosonde spectrum requirements to assist in consolidating WMO's position, well in time for an effective preparation to WRC-2000. Two important ITU-R milestones in that respect would be the Conference Preparatory Meeting (CPM) scheduled for November 1999 and a session of WP 7C/7D in March 1999. The Commission requested the SG-RFC, with the assistance of the WMO Secretariat, to develop and provide the appropriate documentation and guidance on WRC-2000 issues and, in coordination with relevant CBS working groups and CIMO, to develop a strategy for the long-term defence of meteorological radio frequencies.

4.2.44 The Commission noted that the agenda of WRC-2000 also included the allocation of frequency bands above 70 GHz to space-borne passive remote sensing — passive EES and SR services — which were of importance for meteorological activities. It further noted with appreciation that the preparation of the *Handbook on the Use of Radio Spectrum for Meteorological Activities*, in the framework of ITU-R/SG 7/Working Party 7C, under the coordination of Mr R. Barth (United States) and with the involvement of the SG-RFC, was making good progress and was planned to be completed by March 1999.

4.3 GLOBAL DATA-PROCESSING SYSTEM (GDPS)

(agenda item 4.3)

4.3.1 The Commission noted with appreciation the report of the chairperson of the Working Group on Data Processing, Mr A. Kellie (Canada), and noted that the group had addressed several issues related to functions and operations of the GDPS at its ninth session (November 1997), at the conjoint WMO/Comprehensive Test Ban Treaty Organization (CTBTO) Expert Meeting on CTBT

Requirements and WMO/International Atomic Energy Agency (IAEA) Environmental Emergency Response (December 1997), at the Expert Meeting on Environmental Emergency Response (EER) activities (April 1998), which focussed on chemical incidents, at the Expert Meeting on Implementation of GDPS Centres (June 1998), and at the Task Group on WMO/CTBTO Matters (July 1998). The Commission expressed appreciation to Mr H. Allard (Canada) for his exemplary service to the Commission as chairperson of the working group up to February 1998.

DEFINITION OF FORECAST RANGES

4.3.2 The Commission noted that the slightly modified definitions of forecast ranges adopted by CBS-XI were submitted to the fiftieth session of the Executive Council by the president of CBS, after consultation with the presidents of CCl and the Commission for Atmospheric Sciences (CAS), for re-consideration as a matter of urgency and were approved.

THE ROLE OF GDPS CENTRES ON MONITORING THE IMPACT ON THE GDPS OPERATIONS OF CHANGES TO THE GOS

4.3.3 In recent years, GOS had been increasingly experiencing difficulties both from technological changes and from financial pressures. The Commission noted that the difficulties were expected to continue (e.g. caused by the uncertain future of the LORAN radionavigation system and the continuing pressure on the radio frequency re-allocations to Met-Aids). The GDPS was neither well equipped nor organized to detect and assess the impact of changes in the GOS on the operations and operational outputs of the GDPS. The Commission agreed that there was a continuing need to monitor the impact of changes to the GOS on the GDPS operations and recorded the relevant work programme under agenda item 8.

VERIFICATION OF NWP PRODUCTS

4.3.4 The Commission encouraged the enhancement of procedures for the exchange of scores to achieve the intended purposes of exchange, i.e. enabling centres to identify deficiencies or problems and make improvements in their NWP systems (*Manual on the Global Data-processing System* (WMO-No. 485), Attachment II.7, paragraph 23).

4.3.5 The Commission also noted that due to the difficulties inherent in an intercomparison, including differences in numerical computations of the scores, different data cutoff and product availability times and the effects of losses in observational data, the verification procedures could not provide categorical representations of the relative qualities of the individual NWP systems, but did allow the identification of external and internal influences on the performance of an individual system.

4.3.6 The Commission reviewed the proposed Table F and Appendix to Table F which was prepared to clarify the procedures. Those proposals showed the content and format of the monthly verification reports that were exchanged between participating centres. The Commission adopted Recommendation 3 (CBS-Ext.(98)) including Table F and its related Parts A and B (as given in Annex 1 to the recommendation) to replace the current Table F in the *Manual on the Global Data-processing System* and encouraged GDPS Centres to implement those new procedures.

REGIONAL SPECIALIZED METEOROLOGICAL CENTRES (RSMCS) WITH GEOGRAPHICAL SPECIALIZATION

4.3.7 The Commission noted that WMC Washington had accepted to provide back-up services to United Nations humanitarian missions for the RA IV zone of responsibility of the RSMC for providing such services. It agreed that consequently both Washington and Miami had RSMCs with geographical specialization responsibilities and that that fact should be accordingly reflected in Appendix I-1 of the *Manual on the Global Data-processing System*, as given in Annex 2 to Recommendation 3 (CBS-Ext.(98)).

DEVELOPMENT IN NWP AND IN LONG-RANGE FORECAST PRODUCTION UP TO MULTI-SEASONAL SCALE

4.3.8 The Commission noted that there had been considerable progress in the development of long-range forecasting activities at a variety of centres. It was noted that while different approaches gave different results in some cases, with different levels of success, no comprehensive documentation of skill levels was available. It was noted that assessments of the scientific quality of long-range forecasts were not generally provided to users, apart from very simple measures of skill and warnings provided along with products on the Web from some issuing centres.

4.3.9 Several seasonal forecasts were being issued by different centres and institutes and were made available in the public domain via the Internet for the same areas. Those forecasts were noted to differ substantially, due to the inherent low skill. The Commission acknowledged the scientific merit of those differences and encouraged the different approaches as a means to spur on progress on the research fronts. However, concerns were raised that that situation tended to lead to confusion among the public, and ultimately, reflecting back on the science behind the long-range forecasts.

4.3.10 There was agreement on the need to have a more coherent approach to the long-range weather/climate forecasting. It was noted that that coherence was just beginning to take shape within WMO and would, of necessity, involve CBS, CAS and CCl. It was noted that the members had invested heavily over the years to implement a robust operational global infrastructure over a long period of time, including observing systems and data collection (GOS), processing facilities (GDPS) and telecommunications (GTS) and that the emergence of long-range forecasting was placing additional challenge on the WWW systems to adjust to broader requirements of CCl. It invited CCl to arrange for participation of its experts in relevant GDPS activities so that the GDPS and other WWW systems could be adjusted to serve climate requirements.

DEVELOPMENT AND IMPLEMENTATION OF A VERIFICATION SYSTEM FOR LONG-RANGE FORECASTING

4.3.11 The Commission agreed that its role was to develop procedures for the exchange of verification scores, building on the work of CAS with a particular focus on the practical details of producing and exchanging appropriate scores. It was noted by the Working Group on Data Processing that the use of CBS agreed scores should be coordinated with the CCl/Climate Information and Prediction Services (CLIPS) and CAS experts so that seasonal forecasts were issued to the users with quantitative information on the skill that could be expected from past records of performance. CBS experts had proposed two additional scores for consideration, notably root mean square skill score (RMSSS) and relative operating characteristic (ROC). It was further proposed to organize an exchange of verification results on the basis of experimental scores to be exchanged in the first place as given in Annex IV to this report.

PROVISION OF MODEL OUTPUT PRODUCTS AS FORECAST GUIDANCE ON THE OCCURRENCE OF SEVERE WEATHER

4.3.12 The Commission noted that there had been requests from some NMHSs for an extension of NWP output to provide more explicit guidance on the occurrence of severe weather in support of public weather services. That request had been raised formally for instance through the Working Group on Planning and Implementation of the WWW in Region VI.

4.3.13 The Commission felt that there was scope to expand the range of guidance delivered from NWP systems to NMHSs. Requirements and capabilities varied among regional associations so that a universal approach might not be desirable.

4.3.14 The Commission endorsed the following proposal on a cascading process for providing guidance on severe weather as a regional arrangement, including:

(*a*) Preliminary indicative guidance by a large centre with a lead time of more than 48 hours, potentially based on probabilistic ensemble prediction system (EPS) output;
(*b*) More specific "warning" guidance for periods less than 48 hours based on EPS and single/multiple high resolution NWP output;
(*c*) Issue of warnings by the responsible centre, based on detection and tracking of severe weather systems.

The Commission also identified some constraints and complications, as follows:

(*a*) The definition of severe weather varied significantly geographically;
(*b*) The effects of severe weather could be very local in scale;
(*c*) Translation of NWP output into specific guidance and, ultimately, warnings still required human intervention in most cases and was consequently expensive in resources and could require expertise at the local level;
(*d*) The predictability of some components of severe weather, particularly intense thunderstorms and tornadoes, was very restricted and nowcasting approaches were required, with limited scope for coordination between NMHSs;
(*e*) The basic responsibility for issuing severe weather warnings rested with individual NMHSs.

The Commission invited regional associations to consider the following approaches for implementation:

(*a*) Dissemination from larger centres of diagnostic and probablistic products relevant to severe weather (such as thunderstorm indices, probability of heavy rainfall, indications of types of freezing precipitation);
(*b*) Training of staff from NMHSs at larger centres, such as the International Desks at the National Centres for Environmental Prediction (NCEP);
(*c*) Assistance in implementing regional or mesoscale models;
(*d*) Providing NWP output from large centres in a form suitable for input to local forecasting aids;
(*e*) Applying NWP output to the local forecasting aids of an individual NMHS and transmission of output to the NMHS under bilateral agreement.

4.3.15 The Commission further invited the regional associations to make a start by encouraging larger centres in the region to extend the range of disseminated products appropriate for forecasting severe weather. That was particularly appropriate where high-resolution regional models extended over the area of NMHSs without such capabilities. Specific products to begin with could be:

(*a*) The convective available potential energy (CAPE) or other thunderstorm indices;
(*b*) Freezing precipitation;
(*c*) Precipitation (some from global models were already available);
(*d*) Surface wind (particularly high resolution output);
(*e*) Vertical wind shear.

4.3.16 It was accepted that those products were solely NWP-based with no human intervention or quality control on the end product. Feedback from the recipient NMHS would assist in monitoring the quality of the product.

GENERATION, PROVISION AND USE OF ENVIRONMENTAL QUALITY MONITORING AND PREDICTION PRODUCTS AND LONG-RANGE FORECASTS

4.3.17 The Commission reviewed the status of the generation and use of environmental quality prediction products and long-range forecasts as well as some of the known gaps in both. In the case of environmental quality products, there was a general sense that the role of GDPS centres might be somewhat limited due to the very localized nature of environmental incidents, the different arrangements within Member countries for the responsibilities for environmental issues and the several agencies involved at the national level. The Commission agreed that some of the potential areas where the GDPS might be able to contribute were:

(*a*) The provision of high resolution (point profiles) boundary layer information from NWP for major cities susceptible to air pollution;

(*b*) The provision of meteorological boundary conditions for local two- and three-dimensional air quality models;

(*c*) The dissemination of predictions of stratospheric ozone and ultraviolet (UV)-B index products using the existing global capabilities of centres in countries such as Australia, Canada and the United States, among others.

4.3.18 The Commission noted the potential for support as outlined above and agreed that such support should be given in response to regional associations reviewing that as well as their clearly stated requirements.

4.3.19 In the case of long-range forecasts, the Commission endorsed that, beginning with the 1998 *WWW Technical Progress Report* on GDPS, a section on long-range forecasts should be included. Many of those products carried the status of experimental results and were carried on the Internet. The Commission considered it unrealistic to expect that array of new products to be easily encoded in the WMO codes and formats that were used on the GTS. It was emphasized that easy access by the global community of users was important and desirable. The Commission noted that the Internet technologies on the GTS needed to be considered as a means of ensuring global distribution of those products and requested the OPAG on the Information Systems and Services (ISS) to address that requirement.

NWP LOCAL MODELS

4.3.20 The Commission noted, that with the future global NWP models expected to run at resolutions of less than 20 km and the increasing power and falling cost of workstations, the implementation and operations of limited domain local NWP models was becoming a more viable option. It was noted that a number of countries had already benefited from that development as some major centres had made available their workstation versions of such models in particular the NCEP ETA regional model and the RSM and the DWD (Germany) model, for implementation and operation at various NMSs, research institutes and universities; on the other hand, the ALADIN model developed within an international project coordinated by *Météo-France* was now in operational use in most participating countries. In order to facilitate information dissemination to the GDPS community on progress in the implementation of workstation version models, it was agreed that centres should report in the GDPS annual *WWW Technical Progress Report* on models running on workstations.

REVIEW AND SUGGESTIONS FOR SUPPORT ACTIVITIES FOR THE UNITED NATIONS OFFICE FOR THE COORDINATION OF HUMANITARIAN AFFAIRS (UN/OCHA) MISSIONS (FORMER DEPARTMENT OF HUMANITARIAN AFFAIRS (DHA))

4.3.21 The Commission reviewed the support activities described in the arrangements for the provision of meteorological assistance to United Nations humanitarian missions and proposals of amendments which would refine the arrangements to carry out smoothly the support activities and adopted the updated arrangements as given in Annex 3 to Recommendation 3 (CBS-Ext.(98)).

4.3.22 The Commission requested the WMO Secretariat to facilitate the support activities for UN/OCHA by NMCs and RSMCs and to:

(*a*) Prepare a World Wide Web server or sites for OCHA products;

(*b*) Provide a climate database that could be accessed by UN/OCHA;

(*c*) Refer the annex of Appendix I.5 to regional association sessions for their review, as necessary.

4.3.23 The Commission agreed that the World Wide Web was the best tool to provide the products to UN/OCHA. Climate information was probably the most useful information to plan any OCHA activities. Zones of responsibility of RSMCs for providing the back-up services should be adjusted in accordance with the ability of every RSMC.

REVIEW OF RESULTS OF APPLYING MONITORING PROCEDURES FOR SURFACE LAND STATIONS

4.3.24 The Commission agreed that the lead centres for surface quality monitoring, in consultation with their national focal points, should examine the methodology for monitoring the quality of observations of amounts of precipitation from land surface stations and develop appropriate recommendations which accommodated regional variants, if necessary.

4.3.25 The Commission noted that the quality of various observations of precipitation were at times in doubt and reporting practices were not standardized at the global level but rather at the regional level. Due to high spatial variability in the precipitation field, composite precipitation analysis with inputs from radar/satellite data had started to be used by some centres for verification purposes. However, there was a need to devise strategies to improve the correction rate of observed precipitation, which might differ from one regional association to another. The national focal, points together with the designated lead centre in their regions, were probably in the best position to carry that out and to develop suitable recommendations to the Working Group on Planning and Implementation of the WWW in their respective Regions.

ENVIRONMENTAL EMERGENCY RESPONSE (EER)

4.3.26 As regarded the arrangements for emergency response related to nuclear (radiological) emergencies, the Commission noted with satisfaction the results of recent activities which included a conjoint WMO/CTBTO Expert Meeting on CTBT Requirements and WMO/IAEA EER Activities (December 1997) and one seminar conducted for RAs II, IV and V (Montreal) in 1997. In terms of preparedness, the Commission noted with satisfaction that the third in a series of exercises was carried out in July 1997; with participation of all RSMCs, and over 70 NMSs. In the light of the results of the July 1997 exercise and Members' experiences, the Commission adopted updates to current procedures for

the provision of transport model products for environmental emergency response as given in Annex 4 to Recommendation 3 (CBS-Ext.(98)).

4.3.27 The Commission re-emphasized the need for NMS operational contacts to have a continuing dialogue with IAEA contact points on the use and impact of RSMC products in the event of an emergency, and the establishment of local procedures for consultation and exchange of relevant information. There was a further need for NMSs, especially those with facilities to run their own models, to be notified via the GTS of any incidents so that they were prepared to run their own models. For that purpose, the Commission agreed to the designation of RTH Offenbach in addition to the WMO Secretariat as the WMO/IAEA contact points for the purpose of the notification convention.

4.3.28 The Commission also considered requirements related to other types of EER. Taking into account Centres' experience in responding to large-scale fires in 1997–1998 in South-East Asia, the Commission agreed that there was a potential to broaden the scope of the EER procedures. It was considered that the nature and large variety of other types of pollution emergencies would impose limitations on the specification of procedures for response. The timeliness of the services, which could be provided for each incident, would have to be considered on a case by case basis. The readiness and capacity of the Centres to respond on request would have to be factored in. In the light of that, the Commission agreed to the broad arrangements for support for non-nuclear environmental emergency response as given in Annex 4 to Recommendation 3 (CBS-Ext.(98).

CHEMICAL INCIDENTS

4.3.29 The Commission noted with satisfaction that in response to the request made by CBS-XI, a definition of requirements had been developed concerning chemical incidents, focusing on data (meteorological and incident related), tools (including models and visualization facilities) and expertise, as given in Annex V to this report.

4.3.30 The Commission noted that requirements of meteorological support to emergency response for chemical incidents were broad and depended on the nature of the incident. Due to wide ranging characteristics for chemical incidents within the interest of individual countries, the role of the NMS could also vary. The possible role and gaps are given in Annex VI to this report.

4.3.31 The Commission agreed that guidance to NMS should be developed addressing the following issues:

(*a*) Best or optimal observational dataset needed for input to modelling to assure useful output: particularly those that indicated the turbulence regime in the surface layer;

(*b*) Basic micrometeorological information pertaining to atmospheric dispersion and chemical incidents (training document or referenced) as a means for evaluating model outputs;

(*c*) Situations where models could not be used reliably or not at all;

(*d*) Modelling and parameterization schemes (e.g. wet and dry deposition schemes for different chemical species) and output parameters including toxicity (exposure) and intervention levels;

(*e*) Situations where certain dispersion models applied; in view of the large number of available models, guidance was needed on selecting models for implementation at NMSs;

(*f*) General aspects of source modelling of different types of incidents/sources; for example incidents involving pipes, tankers, chemical storage, and fire and give guidance on which kind of models could be used in each type.

4.3.32 The issue of the interface between the NMS and the national environmental disaster management and emergency response agencies, should, *inter alia*, recognize that chemical incidents could also affect areas outside of national boundaries although that possibility was considered as being relatively small. Guidance for development of the NMS interface procedures is given in Annex VII to this report.

4.3.33 The Commission agreed that in the event of large-scale chemical incidents, which triggered requests for international assistance, the arrangements for the provision of meteorological assistance to United Nations humanitarian missions would be applicable. Noting that chemical response products were not intended for public nor wide distribution, suitable dissemination still needed to be considered, such as the proper use of the Web.

COOPERATION AMONG INTERNATIONAL ORGANIZATIONS

4.3.34 The Commission was informed of possible coordination and cooperation among international organizations that shared interests in improving the safe management of chemicals and chemical accidents. The International Programme on Chemical Safety, involving the United Nations Environment Programme (UNEP), the International Labour Organization (ILO) and the World Health Organization (WHO), included a United Nations Interagency Coordination Group for Chemical Accidents, led by the Organization for Economic Cooperation and Development (OECD).

4.3.35 UNEP's Awareness and Preparedness for Emergencies at Local Level (APELL) Programme promoted a process for responding to technological accidents and adopted the United States Environmental Protection Agency (EPA) computer-aided management of emergency operations (CAMEO) programme for international APELL applications.

METEOROLOGICAL SUPPORT FOR, AND OTHER COLLABORATION ACTIVITIES WITH, THE COMPREHENSIVE NUCLEAR TEST BAN TREATY ORGANIZATION (CTBTO)

4.3.36 The Commission recalled that it had agreed at CBS-XI, in the framework of the future work programme of the Working Group on Data Processing, to address potential collaboration between WMO and CTBTO as far

as atmospheric detection techniques were concerned. The Commission noted with appreciation that various activities had taken place culminating with a Conjoint WMO/CTBTO Expert Meeting on CTBT Requirements and WMO/IAEA EER Activities (December 1997). The Commission also noted the conclusion that there was a potential benefit from cooperation and from sharing meteorological data. CTBTO would benefit WMO services regarding atmospheric transport modelling and forecasts of meteorological parameters and weather conditions. There also seemed to be some potential for common use of meteorological observation and telecommunication equipment. In that connection, a small WMO task group with invited CTBTO experts had an exchange of views and further discussions and had identified mutual needs and respective benefits as well as had explored areas of possible future collaboration.

4.3.37 The Commission noted that the CTBTO had a number of requirements for meteorological data and services which could be fulfilled by WMO, such as observed and forecasted global meteorological data for three-dimensional trajectory and dispersion calculations, transport and dispersion products from the RSMCs in the case of a nuclear event detection, meteorological observations, and routine weather forecasting to support on-site inspection teams. On the other hand, WMO would be interested in obtaining meteorological observations from some of the CTBTO stations, using the CTBTO telecommunications system at certain locations to transmit data from WMO observing stations, and for obtaining radionuclide measurement data that could be used for transport model development and verification.

4.3.38 Considering the mutual benefit that could be drawn from their respective activities, the Commission recommended that CTBTO and WMO cooperate in areas related to meteorological measurements and transport modelling, by keeping each other informed on their respective activities in those matters. More specifically, the Commission adopted Recommendation 4 CBS-Ext.(98).

Guide on the Automation of Data-processing Centres (WMO-No. 636)

4.3.39 The Commission noted that the updated *Guide on the Automation of Data-processing Centres* was published in 1998. The Commission expressed its appreciation to members of the Ad Hoc Group to Review this *Guide*, consisting of Messrs K. Prasad (India), Barg (Germany) and A. V. Frolov (Russian Federation) for their valuable contributions in that task. It agreed that in the light of technological developments, there would be a need to keep the publication under review and issue updated supplements as required.

Manual on the Global Data-processing System (WMO-No. 485)

4.3.40 As consequential amendments, the Commission recommended the additions to be used to represent on weather charts the $w_a w_a$ (Present weather reported from an automatic weather station) parameters, in the *Manual on the Global Data-processing System*, Appendix II.4, the symbols used already for the table ww (Present weather reported from a manned weather station) for 77 and 78, but for 89, and the symbol shower(s) of hail with the dark top triangle only (hail symbol) without the white bottom triangle (symbol for the qualifier slight). The new recommended table of symbols is shown in Annex 6 to Recommendation 3 (CBS-Ext.(98)).

4.3.41 In summary, the Commission considered and agreed on a number of updates to the *Manual on the Global Data-processing System* as given in general summary paragraphs 4.3.6, 4.3.7, 4.3.21, 4.3.26, 4.3.28 and 4.3.40.

Status of the World Weather Research Programme (WWRP)

4.3.42 The Commission noted the proposal made by CAS and its endorsement by the Executive Council to set up the World Weather Research Programme (WWRP). The Commission expressed its broad support for the orientation of WWRP to develop improved and cost-effective techniques for forecasting high impact weather and to promote their application among Members.

4.3.43 The Commission invited the Advisory Working Group to propose two representatives to liaise with, and to participate in, the work of the Science Steering Committee for the WWRP, serving as Rapporteurs on Observing Systems (including surface-based and space-based) and PWS, respectively.

Infrastructure needs for seasonal to interannual climate prediction

4.3.44 The Commission was informed of the proposals of the CCl Advisory Working Group and the CBS Group of Experts on Implementation of GDPS Centres. It agreed that there was demonstrable skill in predictions made of the development and intensity of the 1997–1998 *El Niño* event up to several months in advance. However, it also cautioned that in the absence of an agreed set of practices with respect to the products issued, validation techniques and systematic procedures for obtaining feedback from users, there was some difficulty in assessing the current overall effectiveness and value of seasonal forecasts.

4.3.45 Nevertheless, the Commission commended the activities under way within the CLIPS project to inform users of the availability of seasonal forecast products and their limitations. It was particularly gratified with the growing cooperation that existed between GDPS centres, established and emerging climate prediction centres — such as the International Research Institute for Climate Prediction (IRI) — and their sponsors to develop through the CLIPS project an awareness among NMHSs and user groups of the considerable potential in the application of even the limited skill currently available.

4.3.46 The intense 1997–1998 *El Niño* event had afforded an excellent opportunity for GDPS centres and other groups preparing seasonal-scale predictions to evaluate the skills of a wide range of forecast techniques being employed both operationally and in a research

mode. The current retrospective analysis of the 1997–1998 *El Niño* event by a United Nations-wide task force would require a strong underpinning of scientific and technical advice in order to evaluate the overall social and economic impacts of the event. The Commission urged both the operational and research communities to cooperate with the CLIPS project and the United Nations task force in ensuring the success of the retrospective analysis.

4.3.47 The 1997–1998 *El Niño* event underlined the important role of the subregional/regional Drought Monitoring Centres (DMCs) and the drought monitoring aspects of the African Centre of Meteorological Applications for Development (ACMAD) in providing information for emergency relief activities in weather-related disaster affected areas. The Commission felt that those centres should be assisted to improve the quality and dissemination of their products.

4.3.48 The Commission noted that many of the systems for producing seasonal to interannual climate prediction were common to those used for weather forecasting. At the same time, there was a recognition that the nature of seasonal-scale predictions introduced special problems with respect to their distribution and use in global, regional and national contexts. Accordingly, the Commission requested that the president of CBS, in collaboration with his counterparts in CCl and CAS, and in consultation with the wider climate community, should establish as a matter of some urgency a mechanism for examining the issues, with the aim of providing guidance to Members on the most appropriate way forward. The United Kingdom offered to provide funding for holding a meeting based on the mechanism established to address that issue.

ROLE OF WORKSTATIONS IN NATIONAL METEOROLOGICAL SERVICES

4.3.49 Considerable interest was expressed by NMHSs, especially those in developing countries, on the use of workstations, taking into account their decreasing cost and ease of maintenance. Their widespread use at NMHSs should be supported and, to that end, the Commission expressed its appreciation and gratitude to NCEP Washington and the Canadian Meteorological Centre (CMC) for providing training through current operational training desks, and requested the United Kingdom Meteorological Office to consider the possibility of re-establishing the African Desk.

4.3.50 The Commission noted the positive benefits that could be achieved by using modern workstation technology for the processing, displaying and manipulation of meteorological information and products, but recognized the significant cost of development or purchase of such systems, and the on going cost of supporting them. It agreed to include as part of OPAG on Data Processing and Forecasting Systems the task to review and report on uses made of various workstations in NMHSs including such items as costs, software and support, and the identification of potential areas of collaboration and standardization.

4.4 WORLD WEATHER WATCH (WWW) DATA MANAGEMENT (DM) (agenda item 4.4)

DATA REPRESENTATION AND CODES

4.4.1 The Commission noted with appreciation the report of the chairperson of the Working Group on Data Management, Mr K. Kashiwagi (Japan).

4.4.2 The Commission noted with appreciation the work of the Subgroup on Data Representation and Codes of the Working Group on Data Management (WGDM) and thanked its chairperson, Mr C. Dey (United States), for his excellent work.

4.4.3 The Commission recalled Recommendation 9 (CBS-97) defining new entries in the radiosonde table, in instrument type for the water profile measurement table, and in satellite identifier table and additions to BUFR tables for accuracy of buoy location, as well as for ACARS observations and for certain products of ERS-2, implemented on the 5 November 1997. The Commission noted also Recommendation 10 (CBS-98) for use as from 4 November 1998 which contained a list of additions to the binary code tables for representation of cloud distribution for significant weather features, satellite advanced TIROS operational vertical sounder (ATOVS) reports, CLIMAT TEMP data, new EUMETSAT wind products, GOES products and change of width for wave number in wave scatterometer product. Recommendation 10 (CBS-98) also contained additions to common code tables, Table C-1 for originating/generating centres, Table C-3 for instrument type for water profile, Table C-5 for new satellites identification, and the inclusion of a new Common Table C-7 — Tracking technique/status of system used. The Commission also noted the approval by the president of CBS and the President of WMO of the addition of notes to the regulations of FM 92 GRIB and FM 94 BUFR to clarify the coding of the year 2000 (year 100 of the twentieth century).

4.4.4 After six years of development and trials, the Commission considered the final proposal for the CREX code form, regulations and tables. Although the Commission recognized that CREX could, in principle, represent all environmental data, it recommended the fundamental objective of CREX be to serve as a tool to avoid the proliferation of new alphanumeric code forms by permitting the exchange of observations for which no traditional character code existed and which, for various reasons, could not be transmitted in BUFR. The conversion between CREX and BUFR had been facilitated by keeping the respective sets of tables closely related. The Commission agreed that FM 95-XI Ext. 98 CREX should be an operational WMO code form and should be added to the *Manual on Codes* (WMO-No. 306), Volume I.2, Part C, Common features. The Commission adopted Recommendation 5 (CBS-Ext.(98)) defining the CREX regulations and tables.

4.4.5 The Commission agreed that the present FM 92 GRIB edition 1 format had certain limitations which made it difficult to satisfy new requirements arising from the advent of new techniques like EPS, long-range forecasting, climate predictions and ensemble wave forecasts; the multiplication of databases and

distributed database systems requiring remote access; and the multiplication as well as diversification of users. The Commission agreed that, the first version of edition 2 of GRIB (GRIB-2), proposed for that purpose by the WGDM, should be used as an experimental data format with a view, after necessary refinements, to endorsing a final version at CBS-XII for operational implementation in November 2001. The Commission noted, however, that GRIB-2 was not the ultimate solution for gridded data but was rather another step in a continuous evolutionary process.

4.4.6 The Commission reconsidered the freeze placed on changes to GRIB-1 by CBS-XI (general summary paragraph 6.4.12 of the *Abridged Final Report with Resolutions and Recommendations of the Eleventh Session of the Commission for Basic Systems* (WMO-No. 854)) and felt it was more restrictive than necessary to meet ICAO requirements and concerns. It noted the comment made by the ICAO observer to the Expert Meeting on Development of GRIB edition 2 who stated that GRIB-1 table additions which did not affect the WAFS data stream would be acceptable to ICAO. The Commission therefore recommended to modify the freeze in the following way:

(*a*) There would be no change to GRIB edition 1 affecting WAFS products or software;

(*b*) However table additions that did not affect WAFS products or software were allowed.

4.4.7 The Commission was pleased to note the development of a BUFR master table 10 for oceanography in cooperation with the Intergovernmental Oceanographic Commission (IOC)/International Oceanographic Data and Information Exchange (IODE). The Commission recommended the experimental use of that new master table 10 for oceanography with a view to its approval for operational implementation at CBS-XII.

4.4.8 The Commission endorsed the following set of additions to BUFR tables:

(*a*) Additions requested by the Data Buoy Cooperation Panel (DBCP) on encoding buoy data;

(*b*) The addition of entries for coding the equivalent of the code FM 82 SFLOC (atmospherics);

(*c*) New data descriptors for precipitation data;

(*d*) The introduction of agreed new CREX entries (mainly for hydrology, ozone and tide gauge data).

It also endorsed the introduction of a clarification in the BUFR regulations for the compression method of character arrays and for bit length per character.

4.4.9 The Commission further endorsed the addition of a new Common Code Table C-6 containing the list of units which might be used in CREX (and other WMO codes) and a new Common Table C-8 containing a comprehensive list of all instruments flown by satellites.

4.4.10 The Commission endorsed the following additions or changes to character codes (Volume I.1 of the *Manual on Codes*):

(*a*) Amendment to the regulation for clarification in reporting past-weather in SYNOP;

(*b*) Provision for regional practice data (Section 5 of FM 32-34, Section 9 of FM 35-38) and national practice data (Section 6 of FM 32-34, Section 10 of FM 35-38) to part A and part C of the PILOT and TEMP code forms;

(*c*) Inclusion of Section 7 (launch time and type of radiosonde), already in Part B, in all the other sections of the TEMP report;

(*d*) Regulation in TEMP and PILOT defining the layer of wind missing values;

(*e*) Addition of day (YY) to time group (GGgg) in AMDAR (to identify without ambiguity the observations and avoid loss of data);

(*f*) Updates to BATHY and TESAC (instruments information and accuracy of location);

(*g*) Addition of a note in WAVEOB (to indicate that some optional section ought to be present when other sections were coded);

(*h*) Adding a code table to define data-processing technique used when retrieving satellite data (l_4 in SATEM and SARAD);

(*i*) Suppression of the Appendix related to units used for wind in the various code forms by every country in Volume I.1.

4.4.11 The Commission adopted Recommendation 6 (CBS-Ext.(98)) defining the amendments to BUFR and Common Code Tables in Volume I.2 of the *Manual on Codes*, and the amendments to alphanumeric codes in Volume I.1 of the *Manual on Codes*. As regarded the alphanumeric codes, the criteria for reporting missing wind data in PILOT and TEMP would be reviewed when necessary.

4.4.12 The Commission considered the implementation of code changes in relation to the year 2000 problem. It agreed that the introduction of a code change in late 1999 could complicate efforts to ensure that systems were able to cope with the year 2000. The Commission, therefore, recommended that all code changes that would normally be implemented in November 1999 be postponed until 3 May 2000. That applied to the above-mentioned Recommendations 5 and 6 (CBS-Ext.(98)).

4.4.13 The Commission considered the requirement, expressed by CIMO-XII, to report observed quantities rather than qualitative parameters for present weather. Since Meteorological Services and manufacturers were currently heavily involved in the development of automatic weather stations, the Commission gave highest priority to that item on its future work programme, with a view to make a proposal for a new appropriate code to be validated, and then approved by CBS-XII in 2000.

4.4.14 The Commission reviewed the proposed rules and procedures for amendments to the *Manual on Codes*, as followed:

(*a*) General validation and implementation procedures;

(*b*) Fast-track validation and implementation procedures;

(*c*) Procedures for correcting existing entries in the BUFR and CREX tables;

(*d*) Rules for the development and maintenance of new BUFR master tables.

The Commission requested the chairperson of the OPAG on ISS to bring those rules and procedures in line with the new structure of the Commission and to submit them through the president of CBS to the Executive Council as a matter of urgency.

4.4.15 The Commission considered a possible strategy for migration from traditional to table-based code forms. The Commission discussed possible approaches to that issue and recommended several basic strategies to promote progress on use of CREX, BUFR and GRIB as followed:

(*a*) Urge WMO Members to use CREX when requirements were identified for new data types that were required by Members who did not have the capability to handle binary data formats (BUFR);

(*b*) Strongly encourage the use of CREX when new requirements for expansion of traditional codes were identified;

(*c*) Support user requirements and facilitate the use of table-driven data formats whenever possible;

(*d*) Request that new satellite data exchanged on the GTS would be encoded in BUFR or GRIB;

(*e*) Encourage the development of standard software that was easy to install and used for handling data in CREX, BUFR or GRIB.

4.4.16 The Commission agreed that the lack of a standard software interface for the binary data formats hampered the migration to BUFR. It agreed that the wider use of the table-driven formats depended upon the development of widely available, easy to use software. The Commission noted that the CBS software registry, although very useful for bilateral exchange of software, had not fulfilled its role for the development of BUFR. It was also noted that several different types of languages, operating systems and platforms used by WMO Members make the development of a standard package difficult, although a survey would probably show only a few types of standards among the majority of Members. The Commission agreed that the best mechanism to ensure the development and ongoing maintenance of commercial-quality software for dealing with WMO formats was the establishment of a centralized office to support software for the WMO formats (BUFR, GRIB and CREX) in a manner similar to the way the university data (UNIDATA) Office in the United States guided and supported development of software for NetCDF. Noting the importance and utility of that approach, the Commission strongly urged Members to consider the establishment of such an office.

4.4.17 The Commission was concerned that all volumes of the *Manual on Codes* were still not accessible on the WMO server in a format suitable for digital processing. They strongly urged the Secretariat to take action on that matter.

4.4.18 The Commission further noted with satisfaction the publication and distribution of the new 1998 edition of Volume II of the *Manual on Codes*.

AUTOMATION OF VISUAL AND SUBJECTIVE OBSERVATIONS

4.4.19 The Commission considered, at the request of CIMO-XII, the limitations which existed in the automated reporting of meteorological and other variables despite the increased capability of obtaining new types of observations and significantly more data by the use of automatic weather observing equipment. It recognized that the present weather code tables used for automatic weather station reports had shortcomings because new requirements for data and features of sophisticated equipment could not be accommodated within those codes properly. The Commission recognized the continuous need to provide well defined data requirements to enable manufacturers to develop equipment that met the needs of users.

4.4.20 The Commission considered the recommendations of the Expert Meeting on Automation of Visual and Subjective Observations (Paris, May 1997) as reflected in Recommendation 5 (CIMO-XII) — Automatic weather station (AWS) reporting code. That specifically included the development of proposals for observation sampling intervals, changes to the "present weather" encoding procedures, elimination of inconsistencies, better defining some weather events and better reflecting the capabilities of AWSs for quantitative rather than the presently used qualitative reporting. The use of BUFR, CREX or other suitable code for AWS data reporting, the use of water equivalent in mm hr^{-1} as a means of expressing the intensity of all types of precipitation rather than the present subjective or qualitatively determined terms should also be considered. The Commission agreed to establish a mechanism, within the OPAGs on IOS and ISS, to address automation of visual and subjective observations, and noted the particular interest of CAeM in that matter.

WMO DISTRIBUTED DATABASES (DDBS)

4.4.21 The WMO DDBs trial had been running for approximately three years. The Commission noted that the functions envisioned for the WMO DDB had been implemented by many centres, far more than were actively participating in the trial, and noted that the centres operating servers outside of the trial had been as successful as those operating as part of the trial. It was gratified that many Members were using those services and had found that the offered data and products had made an important contribution to their operations. Long-range outlooks and climate forecasts had been particularly useful to some Members. It agreed that the trial had successfully demonstrated the concept and that further operation of a formal trial was no longer necessary.

4.4.22 The Commission noted that although a formal trial was no longer necessary Members should continue to develop DDBs services and urged all Members operating DDBs to provide metadata on their files according to the File Content Description Standards given in Annex VIII to this report. The Commission requested that those standards should be further developed and should be provided to the other technical commissions for their comment.

WMO GUIDE ON DATA MANAGEMENT

4.4.23 The Commission expressed satisfaction that the WGDM had developed a draft outline for a WMO

guide on data management and had provided it to the presidents of the other technical commissions. It noted that the existing *Guide on World Weather Watch Data Management* (WMO-No. 788) was developed several years ago and that changes in computer and communications technology should be reflected in the guide.

INTEGRATED WMO PLAN FOR DATA MANAGEMENT

4.4.24 The Commission noted that Twelfth Congress had requested CBS to coordinate the preparation of an integrated data management plan for all WMO Programmes. It agreed that that should be included in the future work plan of the relevant OPAG.

WGDM INPUT TO THE FIFTH WMO LONG-TERM PLAN (5LTP)

4.4.25 The Commission considered the changes proposed by the WGDM to the sections of the 5LTP pertinent to WWW data management, as discussed in agenda item 6.

QUANTITY MONITORING

4.4.26 The Commission considered the proposal for new global WWW monitoring procedures. It recommended that all Members improve or enhance their real-time monitoring systems in accordance with the current plan for monitoring the operation of the WWW in order to address the deficiencies detected by the current non-real-time monitoring. It agreed that the current annual global monitoring (AGM) should be re-designed to monitor the items listed below more clearly, to identify the deficiencies and to facilitate remedial actions:

(*a*) Regularity of the observations;
(*b*) Completeness and timeliness of the collection of data at NMCs, RTHs and WMCs;
(*c*) Exchange of data on the RMTNs and the MTN;
(*d*) Adherence to WMO standard codes and telecommunication procedures;
(*e*) Implementation of the regional basic synoptic network (RBSN).

4.4.27 The Commission agreed that the proposal contained many interesting ideas but should be developed further. It agreed that the special MTN monitoring was working well and supported the idea that it should be included as a significant part of the proposal. The Commission also supported the principle that a monitoring plan should include a mechanism for remedial action to address identified deficiencies. The proposal should be reviewed by all OPAGs and other technical commissions which might be affected so that a mature proposal could be presented to the Commission.

4.4.28 The Commission noted that from time to time there might occur problems with the availability of products exchanged over the GTS. In order to identify the reasons for those problems, special short-duration GTS monitoring might need to be carried out. Such monitoring exercises should be coordinated by the Secretariat.

4.4.29 Noting that the primary objective of Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationship in commercial meteorological activites, was to increase data availability, the fiftieth session of the Executive Council requested CBS, through its president, to address, with some urgency, a methodology for assessing any increase in data availability. The Commission agreed that, because of the urgency of the issue, one or two consultants could develop options for an assessment methodology. Their findings would be made available to members of the Commission and should be considered along with any comments received from members, by the CBS AWG, and thereafter presented by the CBS president to the meeting of the Executive Council Advisory Group on the Exchange of Meteorological and Related Data and Products, to be held in February 1999. It welcomed the offer made by the United States to provide financial support and to assist in the work of the consultants, if requested. The Commission further noted that given the sensitivity of that issue, it was important for the work to address the following issues:

(*a*) Methodologies for assessing the availability of surface synoptic data exchanged between members on the GTS (that was, "essential" and "additional" data) before and after adoption of Resolution 40 (Cg-XII) should be developed;
(*b*) Methodologies for the assessment of those data exchanges might also be proposed for which historical assessments might not be possible;
(*c*) Methodologies should not be excessively expensive or burdensome for members to implement;
(*d*) Other factors, unrelated to Resolution 40 (Cg-XII), such as changes in observing networks, regional differences or special economic considerations, should be recognized. The consultants should propose how the impacts of those other considerations on the analysis might be minimized;
(*e*) Methodologies for continuing monitoring of future data flow, related to Resolution 40 (Cg-XII), should be addressed; and
(*f*) A presentation method should be proposed from which the assessment results could be easily evaluated by WMO Members.

4.4.30 The Commission was informed that there were differences between Members in the interpretation of Resolution 40 (Cg-XII), that there were concerns about the use of the Internet for the exchange of "additional" data, and that there was the possibility that those issues could lead to rapid changes in data flows. Finally, the Commission recognized that the decision to undertake any data analysis arising from the consultants' identification of methodologies would be made by the Executive Council.

QUALITY MONITORING

4.4.31 Regarding the monitoring for quality of observational data, the Commission noted that current activities conducted by the lead centres were working well and generally meet their goals. That monitoring contributed to the resolution of deficiencies in the quality of observed data, particularly from upper air and surface stations.

4.4.32 The Commission noted also that the requirements of other programmes for quality monitoring and quality assurance were increasing, as could be seen, for example, under the GCOS atmospheric observing component which comprised the respective GUAN and GSN global climate reference networks and which used selected WWW upper-air and surface stations. The Commission was concerned that Germany had detected that on average 70 per cent of CLIMAT data were faulty, of which 20 per cent could not easily be repaired by automatic or manual means. It urged all members to ensure that CLIMAT messages were properly encoded and quality controlled.

4.4.33 The Commission, although its primary concern was the quality of WWW data, was aware of the activities of several International Council for Science (ICSU) and WMO WDCs established under programmes like WCRP, the World Climate Data and Monitoring Programme (WCDMP), the World Climate Applications and Services Programme (WCASP), the Global Atmosphere Watch (GAW), the Hydrology and Water Resources (HWR), etc. to which CBS had committed to provide active support. It considered it appropriate, therefore, to take the initiative in the development of a quality management concept for WWW data that was harmonized to the extent possible with the relevant activities of other WMO Programmes. The Commission agreed that that issue should be considered in the development of the new monitoring procedures.

4.4.34 The Commission noted that most of the major GDPS centres produced monthly statistical verifications of NWPs using WMO standard procedures. It agreed that the complete set of results should continue to be made available to Members through the Web/FTP servers of the Secretariat and/or participating centres.

IMPLICATIONS OF THE INTERNET

4.4.35 The Commission considered the implications of the Internet and the report of the task group created to investigate that issue. It agreed with the overall conclusions of the task group, as followed:

(*a*) The impact of the Internet was a major issue that would continue to grow in importance;
(*b*) The Internet would continue to evolve and that evolution would be driven in unpredictable directions by market forces beyond the control of Meteorological Services;
(*c*) Many NMHSs already used the Internet and all should fully grasp the opportunities presented;
(*d*) There were potential security risks involved with Internet use that must be considered and dealt with;
(*e*) The Secretariat should fully exploit Internet services;
(*f*) In order to exploit fully the capabilities of the Internet, while minimizing security risks, guidance and training should be provided.

4.4.36 The Commission agreed that the Internet could contribute to the implementation of WMO Programmes, the operation of NMHSs, and Secretariat activities in many ways. Possible uses included:

(*a*) Exchange of data and products as an adjunct of the GTS;
(*b*) Exchange of non-time-critical information such as climate forecasts;
(*c*) Dissemination of information to the full spectrum of users including the general public, other government agencies, research and education communities, commercial firms and the media;
(*d*) Public relations and promotion of NMHSs;
(*e*) Collaboration between Members and between different communities;
(*f*) Professional training;
(*g*) Downloading and exchanging software for use by NMHSs;
(*h*) Access to information provided or relayed by the WMO Secretariat.

4.4.37 The Commission recommended that all NMHSs should be connected to the Internet and that that should be kept in mind when planning training and capacity building activities. Once connected, NMHSs should exploit the Internet to the fullest extent possible. That might lead to the setting up of servers for the delivery of weather information and included keeping abreast and taking advantage of the latest server capabilities such as password-protected access and subscription-based push services. The Commission noted that, due to the uneven development and differences in availability of the Internet, some NMHSs, in particular in some parts of Africa and the South-West Pacific, might experience particular difficulties in implementing an Internet access.

4.4.38 The Commission noted that the current Internet could not generally guarantee the quality of service (for example realized reliability and throughput) in all geographical areas, which was required for the operational real-time exchange of meteorological data and products for the WWW. However, the use of the Internet was considered as cost-effective for exchanging information which could accept possible delays, and in certain situations, for operational data exchange.

4.4.39 The Commission agreed that connection to the Internet had serious implications for system security. If not carefully done, connection to the Internet could leave NMHSs' computer systems open to attack by hackers and could compromise the privacy of confidential data held in those systems. It was imperative that all NMHSs carefully consider security issues when planning their connections. The Commission agreed that since links to the Internet resulted in increased exposure, security would become even more important when the GTS began to carry TCP/IP traffic and NMHSs developed gateways between the GTS and the Internet. Once those systems became operational, the GTS would only be as secure as the weakest system. The Commission recommended that all NMHSs implement the necessary security arrangements and facilities and requested the relevant OPAG to develop appropriate guidance (see also general summary paragraph 4.2.43).

4.4.40 The Commission concluded that the possibility of supplementing dedicated GTS links with Internet

links could be considered when the following conditions were met:

(*a*) The Internet link was more cost-effective than the dedicated circuit, taking into account all costs, including security aspects;

(*b*) The level of service provided was adequate to meet operational requirements (e.g. when supplementing or replacing low-speed circuits);

(*c*) It was possible to implement adequate security measures to minimize the security impact on the GTS and other WWW centres.

4.4.41 The Commission decided that additional information was needed to make informed choices on telecommunications services and requested its OPAGs to develop a prioritized list of the data to be received and products to be delivered with projected volume estimates and timeliness requirements for each.

4.4.42 The Commission agreed that a guide on internet practices should be developed. Development of such a guide would require the expertise of a cross-cutting team with Internet experience drawn from telecommunications, public weather services and data processing. Other commissions should also be invited to nominate representatives to this group. The Commission suggested the guide should include advice on what data to put on servers, how the data should be named or described, how it should be accessed, and how the server and the data it contained could be protected from unauthorized use.

4.4.43 The Commission urged every NMHS to implement a Web server and those with servers to include a link to the Secretariat server (http://www.wmo.ch) which should, in turn, include links to every other NMHS. That would allow the public and the media to find easily detailed and accurate local forecasts and other services for many countries from a single site and would greatly improve the visibility of the services provided by NMHSs.

4.4.44 The Commission agreed that the development of the Internet should be viewed as a challenge in the process of building an improved GTS. The introduction of TCP/IP on the GTS was an important element in that regard. The Commission underlined that the development of the Internet was relying on the considerable development of telecommunications infrastructure and services provided by telecommunication carriers. Those developments had also had an important impact on the dedicated telecommunications services which were offered, in terms of quality and cost, which facilitated the implementation of cost-effective dedicated and public networks. Significant examples of those new services were the managed data-communication network services (e.g. the RMDCN in Region VI), frame relay services and integrated services digital network (ISDN).

4.4.45 The Commission noted that there were circumstances in which it was desirable that those accessing data from servers be informed about ancillary information (such as any pertinent caveats for their use). It might also be desirable to provide data to a specific group only (e.g. selected WMO documentation). The Commission noted that the following mechanisms were widely used for making data available on Internet servers and provided a means to inform users of any ancillary information relevant to the information to be retrieved:

(*a*) Access open to anyone. That option did not require identification of users. It allowed presentation and acknowledgement of any ancillary information;

(*b*) Access for registered users. That technique could also ensure positive acknowledgement of any ancillary information, if appropriate, and in addition provided a mechanism to collect information about the users, but without any guarantee of authenticity;

(*c*) Access for authorized users. That option required that users be independently identified before receiving a password which could include acknowledgement of any ancillary information necessary. It allowed authenticated identification of the person who retrieved the data.

YEAR 2000 (Y2K) PROBLEM

4.4.46 The Commission, noting Resolution 5 (EC-XLIX) — The year 2000 problem, was pleased to note the actions taken by the Secretary-General to address that issue. In particular, the Secretariat had sent letters to manufacturers of meteorological equipment to gather information and circular letters to all Members in July 1997 and May 1998 which provided information on the problem and asked Members to inform the Secretariat of their plans for ensuring that their systems were Y2K compliant. The Secretariat, with support from the United Kingdom, had also conducted workshops on that issue in Bracknell in January 1998 and in Prague in August 1998 and had ensured that its importance and potential impact were discussed at many other meetings held in the last 18 months. The Commission reviewed and endorsed the recommendations of the Prague workshop and agreed that the recommendations to NMHSs and the Secretary-General should be included in the report of the present session as given in Annex IX to this report. In addition, the annex included recommendations to CBS for consideration in its work plan.

4.4.47 The Commission was pleased that the Secretariat had established a Web page on the Y2K problem in November 1997. Those Web pages, which were updated frequently, could be reached at http://www.wmo.ch/web/www/y2k-info.html. It suggested that all Members with access to the Internet should check those Web pages periodically. The Commission also noted that the Secretariat had hired a consultant to develop an inventory of critical meteorological computer systems used by Members, giving special attention to developing countries, to collect information on compliance status from Members and suppliers, and to develop recommendations on what actions could be taken by Members with non-compliant systems.

4.4.48 The Commission noted with concern that as of 8 July 1998, over a year after being requested to provide points of contact and the status of their various computer-based systems with respect to the Y2K problem, only

50 per cent (93/185) of the WMO Members had reported their Y2K status in any way. The Commission urged all those Members who had not reported the Y2K status of all their computer-based systems to provide the required information urgently and those who had reported, but who had reported that tests were to be run, equipment to be replaced, etc., should report further whenever significant information became available.

4.4.49 The Commission recalled the request made by the fiftieth session of the Executive Council for the Secretary-General to ensure that appropriate efforts were put into Y2K activities. It was pleased to note that, with financial support from the United Kingdom, the Secretariat had engaged a consultant to follow up the tasks requested by the Executive Council. The United Kingdom indicated that further resources might be made available, if required, to assist the Secretariat with the tasks listed in Annex IX to this report under the recommendations addressed to the Secretary-General. The Commission encouraged other Members to consider providing support to assist with Y2K activities.

4.4.50 The Commission considered the status of RTHs regarding the Y2K problem as reported to the Secretariat by Members. It was pleased that, as of 8 July 1998, 11 out of 32 Member countries operating RTHs had reported that they had run tests and had found their systems to be Y2K compliant. The Commission urged the Member countries who listed their work as "under way" to complete their tests and to report the results as quickly as possible. The Commission was very concerned that three of the Members operating RTHs had not reported on their status. It urged those Members to complete their tests and to take the necessary action to ensure Y2K compliance at an early date and to report on their status to the Secretariat as a matter of urgency. Furthermore, the Commission requested all operators of RTHs to complete and report the results of their Y2K compliance tests by 31 December 1998 and to consult with neighbouring RTHs on that issue prior to 28 February 1999. Members operating RTHs were urged to develop or to refine contingency plans to cover situations where neighbouring RTHs or nodes on the MTN became incapacitated for any reason on or after 1 January 2000.

4.4.51 The Commission held discussions on the following aspects of the Y2K problem:

(*a*) General overview of the problem and status of the basic systems;
(*b*) Telecommunications systems;
(*c*) Data processing and forecasting;
(*d*) Upper-air observing systems;
(*e*) Satellite operations and ground equipment.

It noted that there were many other computer-based systems in use by NMHSs which must be checked to ensure Y2K compliance, but which were generally outside its purview (e.g. the Hydrological Operational Multipurpose System (HOMS), GAW, etc.).

4.4.52 The Commission noted that the character codes as given in Annex X to this report included a reference to the year and software processing those codes could potentially be affected. It also noted that the binary codes (BUFR and GRIB) contained year information recorded as the year of the century with the year 2000 as year 100 of the twentieth century. It urged Members to investigate and correct potential impacts of all those codes on their operations.

4.4.53 The Commission was pleased to note that the United Kingdom had prepared a set of Y2K test data and that it had made those data available on their server. It was gratified to learn that some other major centres would also make test data available. It recommended that those centres provided information on how to use those test data as they became available and encouraged other Members' centres to develop and make similar test data available. It also requested the Secretariat to add pointers to test data to its Web server, as they became available.

FUTURE WORK PROGRAMME

4.4.54 The Commission agreed on the work programme which was taken into account in the CBS working programme and structure (see agenda item 8).

4.5 WMO SATELLITE ACTIVITIES (agenda item 4.5)

REPORT OF THE THIRD SESSION OF THE CBS WORKING GROUP ON SATELLITES (WG/SAT)

4.5.1 The Commission noted the report of the third session of the CBS Working Group on Satellites held in Geneva from 27 April to 1 May 1998. It noted with appreciation the data, services and products provided by the satellite operators in support of the space-based subsystem of the GOS. Such support greatly contributed towards meeting the requirements of WMO Programmes, WMO-supported programmes, as well as other international programmes. Finally, it acknowledged the valuable role played by the Coordination Group for Meteorological Satellites (CGMS) and the Committee on Earth Observation Satellites (CEOS) in responding to WMO requirements and stressed the need to continue those dialogues. Discussions and recommendations were proposed for consideration by CBS as provied in the following paragraphs.

SATELLITE DATA, PRODUCT AND SERVICE REQUIREMENTS

4.5.2 The Commission recalled that, at its eleventh session, it had endorsed a general procedure within which the users' requirements for observations and the capabilities of existing, planned and proposed observing systems to provide them would be reviewed. That procedure would then provide guidance on the development of appropriate observing systems to meet the users' requirements. The role of the Statement of Guidance was to provide an interpretation of the output of the Critical Review, to draw conclusions and to identify priorities for action. The Commission agreed that the Statement of Guidance would be most valuable to space agencies as well as would aid in helping them obtain funding. The Statement of Guidance, together with the output of the Critical Review, was intended to serve two audiences:

(*a*) It informed WMO Members on the extent to which their requirements were either met by present systems, by planned systems, or by proposed systems. It would also provide the means whereby Members, through the technical commissions, could verify that requirements had been correctly interpreted and could update them if necessary, as part of the rolling process;

(*b*) It provided support material to WMO Members in dialogue with satellite agencies regarding whether existing systems should be continued, modified or discontinued; whether new systems should be planned and implemented; and whether research and development would be needed to meet unfulfilled aspects of the user requirements.

4.5.3 The Commission noted that the *Preliminary Statement of Guidance Regarding How Well Satellite Capabilities Meet WMO User Requirements in Several Application Areas* (WMO/TD-No. 913), including NWP, synoptic meteorology, nowcasting, hydrology and agricultural meteorology, had been published as Satellite Activities Technical Document No. 21. The Executive Summary from the *Statement of Guidance* is contained in Annex XI to this report. With regard to user requirements, the ICAO observer recalled the continued requirement for satellite data to detect the existence and extent of volcanic ash in the atmosphere.

IMPROVEMENT OF THE SATELLITE SYSTEM UTILIZATION

4.5.4 The Commission strongly endorsed a new Strategy to Improve Satellite System Utilization as contained in Annex XII to this report and to a set of recommendations to improve satellite system utilization as followed:

(*a*) All operational, research and experimental satellite data with potential usefulness for WMO Programmes should be made available to the users;

(*b*) Satellite operators should consider the inclusion of a data distribution service on board each geostationary meteorological satellite. Users should also be made aware of the possibility of receiving satellite data through alternative means, such as the Internet;

(*c*) Improve the performance of the MTN and the GTS to accommodate the increasing flows of satellite data and products that were necessary to improve the utilization of satellite systems;

(*d*) The expansion of DCP usage for agriculture and hydrology should be encouraged by the relevant WMO technical commissions;

(*e*) WMO should seek potential funding/sponsors to provide workstations and networks in developing countries.

APT/WEFAX TO LRPT/LRIT CONVERSION

4.5.5 The Commission noted the initiative of the Secretary-General to keep WMO Members informed of the status of the transition of the automatic picture transmission (APT) and the weather facsimile (WEFAX) services to low-rate picture transmission (LRPT) and low-rate information transmission (LRIT) services. The Commission strongly supported the three-phase approach to:

(*a*) Keep Members informed;

(*b*) Provide detailed information for equipment modifications; and

(*c*) Provide a technical document explaining how to utilize the new services. It was pleased to note that information related to the transition was being transmitted to WMO Members on a regular basis, as required. Extensive use of the WMO satellite activities home pages was also utilized.

4.5.6 With regard to the transition, the Commission noted that most changes would occur over the period from 2000 to 2009. For LRIT conversion, Regions I (Africa), II (Asia), V (South-West Pacific) and VI (Europe) would have a three-year analogue/digital services overlap period starting in the year 2000. Transition dates for Regions III (South America) and IV (North and Central America) had not yet been finalized. For LRPT conversion, the transition for the morning (AM) satellite would occur from 2003 to 2009, but the afternoon (PM) satellite conversion would not commence until the year 2009. Therefore, users would have to maintain a dual APT and LRPT capability during 2003–2009 if they wanted information from both AM and PM satellites.

EDUCATION AND TRAINING

4.5.7 The Commission recalled that the WMO's Strategy for Education and Training in Satellite Matters was based upon several precepts including the need to train the trainers and to involve the satellite operators in co-sponsoring one or more RMTCs as specialized satellite training centres. In that regard, the Commission expressed its appreciation to EUMETSAT for its co-sponsorship of the Regional Meteorological Training Centres (RMTCs) in Kenya and Niger, and to the National Oceanic and Atmospheric Administration (NOAA) for its co-sponsorship of the RMTCs in Costa Rica and Barbados. However, the Commission noted the lack of any co-sponsorship arrangements to date in Regions II and V. Thus, it strongly encouraged the satellite operators in those Regions (Russian Federation, China, India and Japan) to give consideration to developing some form of co-sponsorship arrangements for RMTCs in their region of coverage. The Commission expressed its appreciation to the Government of Germany for its sponsorship of the African Satellite Meteorological Education and Training (ASMET) Project whose objective was to introduce the use of computer-aided learning (CAL) in satellite meteorology at RMTCs in Africa.

SATELLITE SOUNDINGS

4.5.8 The Commission agreed on the following recommendations concerning satellite soundings:

Television infrared observation satellite (TIROS) operational vertical sounder (TOVS) data in NWP

(*a*) While substantial advances had continued in the use of TOVS data in improving NWP, inaccuracies

in radiative transfer modelling remained significant sources of error, thus hindering further progress. Therefore, major NWP centres and the National Environmental Satellite, Data and Information Service (NESDIS) (United States) should cooperate on the evaluation and improvement of fast radiative transfer models. Those activities should be coordinated with the intercomparison of trasmittance and radiance algorithms (ITRA) plans;

(*b*) The ECMWF reanalysis (1979–1993) showed that the use of the TOVS data clearly improved the quality of the first-guess forecast when two polar orbiters were available instead of one. Thus, satellite operators should take all reasonable steps to ensure that a two-satellite constellation of polar-orbiting satellites was maintained, including overlap periods between successive operational satellites (i.e. a minimum of six months).

TOVS data in climate studies

To achieve consistent data records from different spacecraft, the maintenance of satellite-radiosonde collocation data archives and a substantial overlap period of data processing after the launch of each new satellite were of great importance. Thus, those should be developed further, especially in regard to establishing a full audit-trail for all data on those archives.

Inter-satellite data calibration

(*a*) Improved characterization of total system spectral responses was required. Thus, efforts toward inter-calibration were required to establish techniques and programmes for achieving long-term consistent data records;

(*b*) Future re-analysis projects were likely to require access to stratospheric sounding unit (SSU) and virtual temperature profile radiometer (VTPR) data. Thus, the calibration data and processing procedures, including software, for those instruments should be fully preserved and documented. It was recommended that the United Kingdom Meteorological Office and NESDIS investigate that problem.

Preparations for advanced TOVS operational vertical sounder (ATOVS) data

WMO Members should inform NESDIS of their requirements for ATOVS data/products, especially in view of the higher spatial resolution of ATOVS data products, compared to TOVS.

Advanced sounders

(*a*) With regard to advances in infrared sounders, the Commission noted the significant progress being made on the infrared atmospheric sounding interferometer (IASI), the atmospheric infrared sounder (AIRS) and the infrared temperature sounder (ITS) instruments. Given the importance of sounding from two or more polar satellites for global NWP, the Commission expressed concern that only the advanced sounder from Meteorological Operational Satellite (METOP), IASI, was planned to be operational during the period 2003–2009. It recommended that operational agencies consider how those plans might be improved towards providing comparable advanced sounding capability in both morning and afternoon orbits. In particular, it recommended that NESDIS explore options for upgrading the high resolution infrared sounder (HIRS) to provide advanced sounding capability on NOAA satellites from 2003;

(*b*) Observations of temperature, humidity and wind at high temporal frequency had the potential for improving global and regional NWP through four-dimensional data assimilation. Thus, infrared sounding instruments of high spectral resolution should be considered for inclusion in the payloads of future geostationary satellites.

International issues and future systems

The Commission noted the importance of integrating the operational satellites into one global system, whereby consideration should be given toward developing a mechanism in which the plans of individual space agencies for instruments and missions could be integrated into an overarching strategy that would best address individual countries' needs and international requirements.

Direct broadcast

The Commission reconfirmed that direct broadcast of sounder and imager data on the polar orbiting environmental remote sensing systems was important to the continued effective use of those data by research and operational institutions. It strongly encouraged continuation of that policy by the satellite operators.

MONITORING

4.5.9 The Commission noted with pleasure the intention of the United States to continue its lead role in monitoring satellite data. The United States described plans to invigorate further its satellite monitoring lead centre role to involve satellite data experts in the interpretation of aggregated product quality statistical information.

4.5.10 The Commission noted the increased need for education and training for Members in the western part of Region II who were capable of receiving data from EUMETSAT satellites. The Commission encouraged EUMETSAT to consider providing education and training similar to that presently being done at the specialized RMTCs in Nairobi and Niamey. It also encouraged EUMETSAT to provide information as a matter of urgency for the new high rate user stations (HRUSs) required to receive data from the METEOSAT second generation (MSG) satellites. Finally, it acknowledged the valuable contribution being made by METEOSAT-5 in support of the Indian Ocean

Experiment (INDOEX) in providing data over the data-sparse Indian Ocean. In view of the expected end of life of METEOSAT-5 at the end of 1999, the Commission suggested that EUMETSAT consider placing on orbit spare satellites over the Indian Ocean on a continuing basis, where possible.

4.6 OPERATIONAL INFORMATION SERVICE (OIS) (agenda item 4.6)

4.6.1 The Commission agreed that the Operational Information Service (OIS) had as its objective the collection from, and distribution to, WMO Members and WWW centres of detailed and up-to-date information on facilities, services and products made available in the day-to-day operation of the WWW. It further agreed that in view of the increasing automation of the centres, the efficient and timely dissemination of that information had become increasingly important to ensure the optimum efficiency in the operation of the WWW.

4.6.2 The Commission recalled that CBS-X, CBS-Ext.(94) and Twelflth Congress, had requested a restructuring of the OIS in order to improve data reliability, timeliness of distribution, and the provision of additional information to Members. It was pleased to note that the project, which had been endorsed by CBS-XI, had been successfully completed resulting in moving the data, necessary for the production of *Weather Reporting* (WMO-No. 9) and the *International List of Selected, Supplementary and Auxiliary Ships* (WMO-No. 47), away from its former mainframe platform to a new in-house platform. The restructuring and move had eliminated many of the procedures and obstacles that made the previous system slow and cumbersome while, at the same time, allowing for substantial savings in mailing costs. The project had involved extensive amount of work and training of the staff concerned in the use of the software employed in the restructured OIS. The Commission was informed that the Secretariat now had the capability to maintain and update the data on a near-real-time basis and to provide much greater flexibility for dissemination. It requested that the format and content of the publications available on the Internet be kept under review and that Members be notified in advance of changes planned to be made to those publications.

4.6.3 The Commission noted with interest that both Volumes A and C1 of *Weather Reporting* were being updated weekly and that the updated data was made available every Monday via the Internet, and furthermore that the data files could be accessed via the WMO home page at the following site: http://www.wmo.ch/web/ddbs/publicat.html. It was also informed that the *International List of Selected, Supplementary and Auxiliary Ships* and the RBSN lists were available on the Internet and updated regularly, and that data from all the above publications were also available via FTP from:

Publication No. 9-Volume A:	ftp://www.wmo.ch/wmo-ddbs/Pub9vol Ayymmdd.flatfile
Publication No. 9-Volume C1:	ftp://www.wmo.ch/wmo-ddbs/Pub9vol Cyymmdd.flatfil
Publication No. 47:	ftp://www.wmo.ch/wmo-ddbs/Pub47. ships.yymmdd.data
RBSN lists:	ftp://www.wmo.ch/wmo-ddbs/rbsn.rax

The information was also available in printed form and Members could request it, for example, through e-mail (PWOI@www.wmo.ch). In addition, the expanded diskette service and printed editions had been improved by eliminating long delays in access to the information contained in those volumes. The Commission further noted that the WWW *Operational Newsletters* had been made available on the Internet for quite some time and those subscribers who had the required facilities were strongly encouraged to use it and benefit from the rapid access to that publication.

4.6.4 In expressing its satisfaction with the improved efficiency of the OIS, the Commission urged the Secretariat to utilize the Internet more extensively to facilitate timely distribution of, and access to, other publications. It agreed that the priority should be given in particular to publishing *Manuals, Guides* and code specifications. With respect to Internet support, the Commission requested that the Secretariat make the publications home pages more useful for the widest number of its users by simplifying Internet access and use, for instance by introducing the "resume feature" for downloads. In that connection, the need was expressed to include in the WMO home page as soon as possible a version in the Russian language. The Commission further requested that a suitable feedback mechanism also be put in place to receive suggestions on the usefulness of the format and the accessibility of the operational publications. Finally, the Commission suggested that the Secretariat examine the cost benefit of charging for the publications made available on the Internet.

4.6.5 The Commission recalled that as part of their responsibilities, WMCs and RTHs on the MTNs were to review the Catalogue of Meteorological Bulletins and notify the Secretariat, of changes to be included in *Weather Reporting*, Volume C1. The Commission stressed that the objective of the OIS could not be achieved unless changes to be reflected in relevant publications were communicated to the Secretariat promptly by Members. In that connection, the Commission urged the designated RTH focal points and Members to assist the Secretariat in keeping WWW operational publications current by ensuring that all changes would reach the Secretariat without delay. It further urged Members to examine their entries in all of the publications listed above and to, thus, benefit from the restructured OIS for access to the up-to-date and correct information required for their operations.

4.7 PUBLIC WEATHER SERVICES (PWS) (agenda item 4.7)

4.7.1 The Commission noted with appreciation the report of the chairperson of the CBS Working Group on Public Weather Services (PWS), Mr D. Wernly (United States), and expressed its gratitude for the excellent work he carried out during his term as chairperson. It was

pleased with the progress made in the development of the PWS Programme and its implementation, which had continued successfully according to the decisions of Congress. The Commission urged that more financial resources should be made available to the programme in the next financial period in order to allow it to meet the growing requirements and expectations of Members.

4.7.2 The Commission noted with interest that a number of Members had designated experts as members of the Working Group on PWS, established by CBS-XI (Cairo, 1996), and that all regional associations had identified Regional Rapporteurs on Public Weather Services as core members. Two expert meetings comprising primarily the regional rapporteurs had been held in Nassau and in Uruguay in 1997 and 1998, respectively. The meetings had reviewed the development and implementation of the PWS Programme, had established a list of strategic goals, had examined regional priorities, and had eveloped proposals based on those priorities, in the framework of the Long-term Plan. In addition, the chairperson of the Working Group had, through circular letters, communicated with the members of the group and had invited their active involvement in the many tasks included in the terms of reference of the working group.

4.7.3 The Commission expressed satisfaction at the development and distribution of a questionnaire to Members in 1997 to help assess the current state of their PWS Programmes. Over 100 Members had responded to the questionnaire. An expanded version of the *Guide to Public Weather Services Practices* (WMO-No. 834) was under preparation and the Commission urged that that be completed as soon as possible. The expanded *Guide*, which would also be distributed electronically, would emphasize the concept of providing service in a more user-focused manner. The valuable information obtained from the survey would be used for the continuing development of the *Guide* and for addressing further the strategic goals of the PWS Programme, as well as being made available to all Members. The Commission expressed appreciation to the United States for providing support for the analysis of the questionnaire and for the preparation of the expanded *Guide*, and to the Regional Rapporteurs on PWS for their collective efforts and inputs regarding both projects.

4.7.4 The Commission agreed that capacity building activities within the PWS Programme should be strengthened and that continued high priority should be given to the education and training element of the PWS Programme through cost-effective training activities coupled with training events of other scientific and technical programmes of WMO. In that connection, the Commission was pleased to note that several regional training events on PWS had been organized since CBS-XI. The Commission expressed its appreciation to those Members who had assisted with training events and had provided guidance and assistance to other Members. The Commission emphasized the importance of training, particularly for developing countries, and urged that more training events should be organized.

4.7.5 The Commission acknowledged that access to climatological information had become increasingly important to the public particularly as it related to severe and extreme weather events. That point had been amply demonstrated by the 1997–1998 *El Niño* event. It further agreed that all users, including Governments, the private sector and the general public, would be in a position to make better decisions that would lead to reducing risks and improving sustainable development, if they could effectively use weather and climate information. The Commission noted that the CLIPS project, established as part of the WCASP, would be used to convey climate information to NMHSs for various applications including sustainable development, human health and security. Thus, close cooperation between CLIPS and the PWS Programme should be encouraged.

4.7.6 The Commission noted that although the public had increasing access to meteorological information through, for example the Internet, it often required assistance from professional meteorologists to interpret such information and thus benefit from the useful guidance provided in order to make sound decisions. In that connection, the Commission stressed the valuable opportunity that existed for NMHSs to be recognized as authoritative issuing entities of public weather products on time-scales ranging from warnings to seasonal forecasts. Thus, in view of the above and of its programmatic cross-cutting nature, the Commission underscored the importance of active collaboration between the PWS Programme and other scientific and technical programmes within WMO, as well as the need for a clear definition of roles, with a view to assisting the NMHSs to achieve the most effective delivery of meteorological information and services to the public.

4.7.7 As regarded the provision of meteorological and hydrological information in support of United Nations humanitarian missions related to natural disasters and other crises, the Commission was informed that WMO had, through the PWS Programme continued its cooperation with UN/OCHA (formerly DHA). The usefulness and success of the cooperation with OCHA was demonstrated during the critical stages of the forest fires in South-East Asia in 1997 when arrangements were put in place for UN/OCHA to access meteorological information from various centres.

4.7.8 The Commission noted that concern was still expressed by Members, especially those from the developing countries, on the role of international broadcasters *vis-à-vis* the NMHSs. It requested that discussions continue through the PWS Programme with producers and disseminators of international television broadcasts on issues involving media communications. The Commission welcomed the presence of observers from the International Association of Broadcast Meteorology (IABM) and felt that links with such organization and the international media in general, should be strengthened without delay to address concerns raised by several delegates.

4.7.9 In considering the areas that needed particular attention in the future work of the PWS Programme,

the Commission stressed that one of the most fundamental roles of NMHSs was the provision of effective PWSs in support of safety of life and property. However, it also agreed that aside from the threat of natural hazards, several other factors underlined the need for each nation to support strong public weather services. One of those factors was that government resources in support of NMHSs activities would come under increased scrutiny while pressures would be greater to recover costs where possible. Even if cost recovery was not an issue, strong justifications wouldhave to be made to demonstrate to funding authorities the benefits derived from services provided. It was therefore becoming increasingly essential that if NMHSs were to continue to play a role in the prevailing economic and political conditions, they needed to ensure that the core function of providing PWSs was made more visible, useful, and relevant to the users. In doing so, it should be kept in mind that as the population was becoming more weather-sensitive, better information concerning future hydrometeorological conditions were having a profound effect on local and national businesses and economies and on the lifestyle of the people in reaction to variations in the daily weather. Accordingly, growing demands for meteorological forecasts and information coupled with the increasing sophistication of users meant more detailed and accurate information to satisfy users' needs. Similarly, in making their decisions based upon the level of risk they were willing to accept, users increasingly required that NMHSs acquired enhanced abilities to quantify the uncertainty in their forecasts. Thus, the Commission stressed the need for NMHSs to focus on the enhancement of those services and become more requirements-oriented.

4.7.10 The Commission stressed that in order to achieve the above, continuous development of strategies to assess requirements, development of products and services to meet those requirements, education on the best use of NMHSs products and services, and the assessment of satisfaction should become an integral part of the activities of NMHSs, for instance through the use of market research techniques. Another important factor in the evolvement of PWS was the continuous and rapid development in science and technology, coupled with the dynamic nature of dissemination systems and communication pathways, and significant improvements in graphics display capability which would result in NMHSs having the ability to communicate highly detailed information in more graphical ways to ensure receipt and better understanding by the end-users, particularly in multilingual countries.

4.7.11 The Commission reviewed the report of the first meeting of the core members (i.e the regional rapporteurs) of the Working Group on PWS. It noted with appreciation that the programme had moved to a more action-oriented phase and substantial progress had been made in addressing some of the major issues concerning the PWS Programme. In particular, the meeting had re-assessed the strategic goals of the programme and modified them accordingly to reflect the recent developments and the new requirements set by the Executive Council at its fiftieth session.

4.7.12 The Commission also noted the various recommendations of the working group. It agreed that, as regarded dissemination and presentation of public weather forecasts and warnings, the relevant CBS OPAGs should consider those issues in their programme of work.

4.7.13 As regarded disaster reduction activities, the Commission underlined that Members required assistance in their efforts towards establishing better partnerships and collaboration with disaster management authorities and the media as part of achieving the above goal.

4.7.14 Concerning the cross-border coordination and exchange of information on hazardous weather, the Commission noted the aspects regarding the types of information, format, language, thresholds, and the role of RSMCs in the exchange process. It also noted the steps identified by the working group to encourage the establishment of increased bi- and multilateral warning exchange in the regions concerned and emphasized the role of regional associations in that process.

4.7.15 Concern was expressed that, in some cases, the forecasts and warnings disseminated by the international media were at variance with those of the NMHSs. The Commission agreed that action should be taken to improve the situation as regarded the relations of NMHSs and the international media. The action should include collection of information on the present status of those relations and monitoring of the situation. Based on the information thus obtained, discussions should be held with the international media with the aim of developing a process for resolving issues and improving relations.

4.7.16 The Commission recognized that accomplishing the work of the programme would require seminars and workshops as well as the development of guidance material and that, in some cases, a global approach to the issues was appropriate while, in others, a regional or national approach would be required.

4.7.17 In translating the factors in previous paragraphs into the mandate of the PWS Programme, the Commission requested that the following issues be addressed:

(*a*) Strengthen NMHSs' visibility through better relationships with their Government, key recipients of PWSs and products and the media, in particular through taking a more pro-active role with the media and ensuring that forecasters were equipped with the necessary skills for working with the media;

(*b*) Strengthen and increase NMHSs' capacities in providing weather services to meet users' requirements based on their lifestyle, culture, and economic activities, including guidance on methodologies for assessing user requirements and degree of satisfaction;

(*c*) Strengthen NMHSs' abilities in creating warnings and forecasts that met user expectations including guidance on what constituted effective warnings and forecasts; how to quantify forecast uncertainty; and on best practices for the verification of warnings and forecasts;

(*d*) Strengthen NMHSs' presentation and dissemination capabilities through preparation of training materials and conducting courses in techniques for the presentation and dissemination of public weather products; encouraging the understanding and utility of the Internet in addition to television, radio, newspapers, and telephone and facsimile services, particularly in developing countries; assisting developing countries with access to the above means of mass dissemination;

(*e*) Strengthen NMHSs' capabilities to raise public awareness and educate technical users through, *inter alia*; developing guidance material aimed at raising the level of public response to warnings of severe weather; involving such users and PWS partners such as disaster management agencies and the media in training events; and arranging for the exchange of best practices on developing training programmes for technical users;

(*f*) Strengthen NMHSs' capabilities to coordinate information exchange on hazardous weather among neighbouring countries through working with the regional associations to develop arrangements, procedures and agreements for pre-warning consultation and sharing of warning information;

(*g*) Develop a methodology for the international exchange of NMHS forecasts for the public as part of efforts to enhance the visibility of NMHSs;

(*h*) Develop guidelines and examples of best practices in order to achieve a positive and cooperative partnership with the national and international media concerning the dissemination and use of NMHSs' official products and services, investigate the receipt of NMHSs' warnings by the international media in support of warning dissemination according to the principles of attribution, and acknowledging national NMHSs as the sole official voice for warning.

4.7.18 The specific future work plan addressing those issues is given under agenda item 8.

5. DEMONSTRATION FOR REGIONAL SPECIALIZED METEOROLOGICAL CENTRE (RSMC) CAPABILITIES (agenda item 5)

The Commission noted with appreciation the report of the Fiji Meteorological Service on RSMC Nadi upgrades. It noted with satisfaction the successful implementation in March 1998 and the operation of all components of the project for the upgrading of meteorological observation and forecasting systems. The Commission noted the substantially enhanced capabilities of RSMC Nadi which resulted from the project. The Commission also appreciated the efforts and investment of human and other facilities of the Government of Fiji in the development and modernization of all aspects of the Meteorological Service and the RSMC in particular for the benefit of the South-West Pacific Region. It thanked the Government of Japan for the substantial contribution to the project. It also recognized the important contributions made by the Governments of Australia, New Zealand and the United States. The Commission invited RSMC Nadi to enhance its collaboration with countries in the Region to assure the efficient exchange of cyclone monitoring information and the provision of warnings and forecast services.

6. LONG-TERM PLANS (agenda item 6)

6.1 MONITORING AND EVALUATION OF THE THIRD (3LTP) AND FOURTH WMO LONG-TERM PLANS (4LTP) (agenda item 6.1)

6.1.1 The Commission reviewed the implementation of the Third and Fourth WMO Long-term Plans as regarded the programmes under its responsibility. The Commission noted that the president had presented a report on that implementation to the Executive Council Working Group on Long-term Planning, in accordance with the guidelines and directives developed by the Executive Council for monitoring and evaluating the implementation of the Plans.

6.1.2 The Commission noted that following the amendments to its terms of reference by Twelfth Congress, it had provided support to other WMO and several related non-WMO Programmes through the basic systems, taking into account new requirements that emerged, *inter alia*, from the United Nations Framework Convention on Climate Change (UN/FCCC) and from Agenda 21. The main activities centred on contributions to the World Climate Programme (WCP) (data representation forms, improvements in the availability of climate data), operational hydrology (telecommunications for the World Hydrological Cycle Observing System (WHYCOS)), GCOS (establishment of atmospheric observing networks), and development and implementation of operational arrangements for the provision of meteorological services through designated RSMCs in emergency situations in collaboration with IAEA and UN/OCHA, input to the Tropical Cyclone Programme (TCP), the International Decade for Natural Disaster Reduction (IDNDR) and several others.

6.1.3 The Commission was pleased to note that during the inter-sessional period the president and working groups also dealt with matters relating to PWS commercialization of meteorological services, the role of NMHSs, and satellites for environmental observations and telecommunications. The GDPS, GOS and the GTS components were further developed and the level of system integration of the WWW was improved through the Data Management programme. The Commission was pleased that progress was achieved in implementing elements of the composite observing system and improvements were implemented in the OIS. Important technical advice on the implementation of Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities, was provided and the impact of the Internet on the operation of the NMHSs was assessed. A cross-programme task to compile a list of requirements of all WMO Programmes for the exchange of data and products was completed and those

requirements were adopted for inclusion in the WMO Technical Regulations.

6.2 **PREPARATION OF THE FIFTH WMO LONG-TERM PLAN (5LTP)** (agenda item 6.2)

The Commission considered the draft text for inclusion in the Fifth WMO Long-term Plan concerning the WWW and PWS. It proposed changes to the text as given in Annex XIII to this report.

7. STRUCTURE OF THE COMMISSION FOR BASIC SYSTEMS (CBS) (agenda item 7)

7.1 The Commission recalled the request made by the forty-eighth session of the Executive Council for the Commission to study the most efficient way of organizing the working structure of CBS in view of the need for far greater resources in terms of expertise and funds to fulfil its responsibilities than were currently available to the Commissions. It further recalled that CBS-XI had established a task team to examine and advise on options for restructuring CBS. The Commission received with appreciation the report of the task team which contained proposals for a new working structure of the Commission. It underlined that those proposals were developed under the assumption that the WMO financial resources allocated to the WWW Programme and the CBS activities would not change. The Commission thanked the members of the task team, Messrs H. Allard (Canada), N. Gordon (New Zealand) and Yan Hong (China) for the excellent work and for achieving what was a daunting work.

7.2 In view of the further growing tasks and responsibilities the Commission would have to cope with, it underlined the urgent need to find ways to increase its output without increasing the costs. The Commission was of the view that the current system of large "open" CBS working groups meeting every four years was no longer the best way forward. It concluded that, in principle, the most effective, flexible and responsive means of carrying out CBS functions and tasks was through a system of smaller teams that focused on well-defined tasks identified by the Commission. Those teams would comprise a high level of expertise in Expert Teams (ETs) and would involve the regional associations in the work of the Commission through Implementation/ Coordination Teams (ICTs). The Commission agreed to group the activities of the Commission under four main headings or "programme areas":

(*a*) Integrated Observing Systems;
(*b*) Information Systems and Services;
(*c*) Data Processing; and
(*d*) Forecasting Systems and Public Weather Services.

The activities under each of those programme areas should be led by the chairperson of OPAG related to each of the programme areas. The members of the OPAGs would be consulted and informed by correspondence. An important task of the chairperson would be to ensure the regular flow of information on the activities of the topical expert teams in his/her programme areas. The Expert and Implementation/Coordination Teams of the OPAGs were established by the CBS Advisory Working Group or the chairperson of an OPAG in coordination with the president, or by a session of the Commission. The Commission stressed that the success of the new structure would depend to a great extent on the strengthened role of the Advisory Working Group in assessing and guiding the activities of the OPAGs. Another important precondition for the success of the new structure was that the WMO language support met the requirements of the members of the Commission so as to allow full participation in the work of the OPAGs, of the Expert Teams and of the Implementation/ Coordination Teams.

7.3 The Commission analysed the different aspects of its new structure. It emphasized the need to integrate fully the observing system components into a single programme area to address better the technical aspects, while underlining that the liaison between the WMO and the satellite operators, carried out through the WMO satellite activities programme, included policy and technical aspects. The Commission was of the opinion that the policy aspects might need to be dealt with by the policy-making organs of WMO and that a new mechanism might need to be developed in that respect. The Commission thought it crucial that the OPAG on IOS be actively involved in developing such a mechanism.

7.4 The Commission stressed the importance of improved links with the regional associations, their greater involvement in planning, implementation and coordination of the WWW at the regional level and, most importantly, in providing feedback to CBS. It called on the regional associations and, in particular, the chairpersons of the Regional Working Groups on the Planning and Implementation of the WWW to seize that opportunity and to assist in the selection of participants/ members of developing countries from their Regions in the various OPAG teams.

7.5 The Commission also stressed that the information from the Advisory Working Group and the OPAGs should be made available to all members of CBS in a prompt and effective way. That included the use of modern communication systems, such as Internet, complemented by mail to accommodate the specific difficulties of developing countries.

7.6 The Commission underlined that the role of the OPAG chairpersons was a critical element for the success of the new structure and that the expectations put on them were extremely high as regarded their expertise and time to be invested. Teams were expected to adopt flexible working mechanisms, including electronic corrrespondence, while paying attention to the cohesion of the experts involved and providing the necessary forums. The Commission also noted that the new highly-focused Expert Teams might weaken the training element inherent to the old large working groups. It felt that that could be compensated by increasing the WWW-related training workshops and seminars, whenever that was possible.

7.7 The Commission invited the Secretariat to adapt its working methods in order to support in an

optimal way the new working mechanisms of the Commission, including the facilitation of the circulation of information within the OPAG and to CBS members, and the support to meetings and other working mechanisms of the various OPAG teams. The Commission requested the Secretary-General to adapt the list of meetings/events planned for 1999 within the current financial allocation to the extent possible to match the meetings required in the new CBS structure.

7.8 The Commission decided to implement the new working structure by adopting Resolution 2 (CBS-Ext.(98)) and agreed to assess the impact and effectiveness of the new working structure at its next session.

7.9 The Commission further decided to re-establish the CBS Advisory Working Group by adopting Resolution 3 (CBS-Ext.(98)) and to establish the OPAGs by adopting Resolution 4 (CBS-Ext.(98)).

8. COMMISSION FOR BASIC SYSTEMS (CBS) WORK PROGRAMME; ESTABLISHMENT OF WORKING GROUPS AND RAPPORTEURS (agenda item 8)

8.1 The Commission established the Advisory Working Group and OPAGs under agenda item 7 and agreed on its work programme for the next two years based on the relevant sections of the Fourth WMO Long-term Plan and relevant decisions of the Executive Council and taking into account the detailed discussions under the various agenda items.

8.2 With a view to facilitating the task of the Advisory Working Group and the OPAG chairpersons in establishing Expert Teams, Implementation/Coordination Teams and Rapporteurs to carry out efficiently the various tasks, the Commission identified the main elements of the work programme for each OPAG, and consequently listed the relevant tasks. The work programme for the four OPAGs are included in Annex XIV to this report. The Commission also recalled that the Steering Group on Radio Frequency Coordination was maintained and was now part of the OPAG on ISS (see general summary paragraph 4.2.38).

9. REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND RELEVANT EXECUTIVE COUNCIL RESOLUTIONS (agenda item 9)

In accordance with established practice, the Commission examined those resolutions and recommendations adopted prior to its extraordinary session which were still in force and adopted Resolution 5 (CBS-Ext.(98)). It also examined the Executive Council's resolutions within the field of CBS and adopted Recommendation 7 (CBS-Ext.(98)).

10. DATE AND PLACE OF THE TWELFTH SESSION (agenda item 10)

The Commission agreed that, subject to the receipt of any formal offer, the date and place of its twelfth session, tentatively planned for the fourth quarter of 2000, should be determined by its president after consultation with the Secretary-General and in accordance with the provisions of General Regulation 186.

11. CLOSURE OF THE SESSION (agenda item 11)

11.1 In his closing remarks, the president of the Commission, Mr S. Mildner, reviewed the work of the extraordinary session. He stated that in light of the complexity and sensitivity of the issues considered, the session had been conducted in an excellent spirit of cooperation and had been a great success. He thanked all of the participants for their valuable contributions which had allowed the session to achieve its objectives. He thanked all those who had contributed to the smooth running of the session, particularly the co-chairpersons of the working committees and the participants in the ad hoc and drafting groups. He expressed his appreciation for the fine work of both the WMO and the local Secretariats. On behalf of the Commission and the participants, the president extended a special thanks to the city of Karlsruhe for its generous hospitality.

11.2 The extraordinary session (1998) of the Commission for Basic Systems closed at 5.30 p.m. on 8 October 1998.

ANNEX TO RESOLUTION 2 (CBS-Ext.(98))

WORKING STRUCTURE OF THE COMMISSION FOR BASIC SYSTEMS

1. The Commission agreed that the most effective, flexible and responsive means of carrying out well-defined CBS tasks is a system of small teams and rapporteurs complemented by suitable ways to involve and inform all CBS members in the process.

2. The activities of CBS are grouped under four main programme areas:

(*a*) Integrated Observing System;
(*b*) Information Systems and Services;
(*c*) Data-processing and Forecasting Systems;
(*d*) Public Weather Services.

The activities under each of these programme areas are handled by Open Programme Area Groups (OPAGs), the members of which are regularly consulted and informed by correspondence. This achieves a broad ownership of the plans, concepts, procedures, etc. developed by CBS through the active involvement of a large number of individual experts from among the CBS members. The chairperson of each OPAG is also the coordinator of the work of the small teams and rapporteurs related to that specific programme area.

CBS Advisory Working Group

3. The Advisory Working Group consists of the president, vice-president, the chairpersons of the four OPAGs, along with the minimum additional members needed to ensure regional representation. The AWG has a much strengthened and more active role in guiding the Commission's activities between sessions. It is responsible for ensuring the integration of the programme areas, for strategic planning issues, for the evaluation of the progress achieved in the agreed work programme and for related necessary adjustments to the working structure in the inter-sessional period. The AWG should normally not exceed eight members in total and will meet annually. The terms of reference for the AWG are decided by the Commission by means of a resolution. The reports of the session of the Advisory Working Group will be regularly distributed to members of the Commission.

Open Programme Area Groups (OPAGs)

4. The terms of reference, terms of office and designation of the chairpersons of the OPAGs are decided by CBS by means of a resolution. While the terms of reference are normally of a general nature, CBS agrees, in addition, on the respective work programmes. The work programmes specify the issues and tasks the OPAGs are requested to pursue during the inter-sessional period of CBS. The chairpersons will submit their reports to the next session of CBS.

5. The OPAGs do not hold sessions and their members are consulted and informed through correspondence. The information flows from the chairpersons to the members through suitable means of distribution such as circular letters from the CBS president or the chairpersons, the WWW *Operational Newsletter*, and the WMO Internet Web site.

Expert and Implementation/Coordination Teams

6. There are two types of teams. An Expert Team (ET) is mainly based on expertise for developing proposed solutions to scientific/technical problems and for studying issues for which very specific expert knowledge is needed (e.g. binary data representation forms or telecommunications protocols). An Implementation/Coordination Team (ICT) is mainly based on regional representation and focuses on coordinating operational and implementation aspects. It may be more effective to establish a rapporteur instead of a team for certain specific tasks. The rapporteur should be seen within this working structure as a "one-member" team.

7. Explanatory information referring to the teams is given in the following table. The ET and ICT of the OPAGs are established by the CBS Advisory Working Group or the chairperson of an OPAG in coordination with the president, or by the session of the Commission. The leaders of both types of teams are normally designated by a session of CBS. In the inter-sessional period, the team leaders will be designated by the president upon a recommendation from the chairperson of the OPAG (COPAG) concerned. Members of the ETs are designated by their team leaders in consultation with the COPAG or the AWG. The membership of the ICT (including the team leader) will include the regional rapporteurs on the specific programme area, who are regularly designated by the regional associations, and up to two additional members, as a source of expertise, designated by the team leader in consultation with the COPAG. Another two members from developing countries, as a capacity building measure, may be designated by the team leader in consultation with the chairpersons of the regional WWW working groups. It is the task of the Secretariat to facilitate this consultation and the necessary flow of information outside CBS sessions.

	OPAGs	*Expert Teams*	*Implementation/Coordination Teams*
Terms of reference	CBS resolution	Annex to general summary of CBS, the AWG or the president	Annex to general summary of CBS, the AWG or the president
Work programme	General summary of CBS	General summary of CBS or AWG	General summary of CBS or AWG
Chairperson	Chairperson determined by CBS resolution	Team leader designated by CBS (general summary) or president or COPAG between sessions	Team leader designated by CBS (general summary) or president or COPAG between sessions
Membership	Open	Decided by team leader in consultation with COPAG	- Regional rapporteurs; - Up to 2 members as additional source of expertise invited by team leader in coordination with COPAG; - 2 additional members, as capacity building measure, from developing countries designated in consultation amongst team leader and regional WWW working group chairpersons.

8. ETs and ICTs are created to perform agreed tasks within agreed time schedules and are disbanded thereafter. Once established, the teams will perform their tasks and provide their reports to their parent body. This may be achieved by correspondence or meetings, as necessary. The process is entirely determined by the nature and the urgency of the task(s) entrusted to the teams. The need for, and the sequence of, meetings should be explicitly considered when establishing the teams. Every team report will be accessible through the WMO Web site and distributed by regular mail, as necessary.

Liaison between CBS and the regional associations

9. It is expected that this working structure significantly improves and strengthens the links to the regional associations and ensures their greater involvement in the planning, implementation and coordination of the WWW at the regional level and, most importantly, through an improved mechanism for providing feedback to CBS (see also paragraph 7 above). This contributes to the process of consensus building, achieves full participation in the CBS decision-making process and broadens the information flow. When setting up the various teams at the CBS session, the chairpersons of the regional WWW working groups provide important advice. Facilitated through their official participation in CBS sessions, they advise the CBS on the composition of the teams from their regional perspective, and they also have an important input as regards the selection of experts from their Region.

10. Particular emphasis has been placed on the involvement of experts from developing countries in the activities of CBS. This involvement has manifested itself in the participation of developing country experts in sessions of CBS-related groups and, to some extent, is seen as an important means of strengthening the knowledge and capabilities in these countries. CBS has a strong interest to continue this practice because it improves, in the long run, the countries' ability to participate, in and contribute to, the WWW system.

RESOLUTION 3 (CBS-Ext.(98))

ADVISORY WORKING GROUP OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The *Abridged Final Report with Resolutions of the Fifth World Meteorological Congress* (WMO-No. 213.RC.28, general summary paragraph 7.13.5,

(2) Resolution 1 (CBS-XI) — Advisory Working Group of the Commission for Basic Systems,

(3) The decisions of the Commission on its future structure as reflected under agenda item 7 of the abridged final report of this session;

CONSIDERING:

(1) That a working group is of value in advising the president of the Commission and in assisting him in his duties of coordination and planning,

(2) That under the adopted new structure of the Commission a working group will be required to guide the Commission's activities between sessions and coordinate cross-cutting aspects of the main programme areas as well as the strategic planning,

DECIDES:

(1) To re-establish the Advisory Working Group of CBS with the following terms of reference:
   (*a*) To advise the president on all matters related to the work of the Commission;
   (*b*) To assist the president in planning and coordinating the work of the Commission and its working groups;
   (*c*) To keep under review the internal structure and working methods of the Commission and make necessary adjustments to the working structure in the inter-sessional period;
   (*d*) To assess and evaluate the progress achieved in the agreed work programme of the Commission and give guidance and advice on the activities of the working groups and the corresponding teams established under their responsibility;
   (*e*) To monitor the implementation of the WWW Programme in relation to the WMO Long-term Plan and advise the president on appropriate actions;
   (*f*) To ensure the overall integration of the programme areas and to coordinate strategic planning issues;
   (*g*) To advise the president on matters related to cooperation with other technical commissions and support to other WMO and related programmes;
   (*h*) To advise the president on all team leader designations necessary between sessions of the Commission;

(2) That the composition of the Advisory Working Group shall be as follows:
   (*a*) President of CBS (chairperson);
   (*b*) Vice-president of CBS;
   (*c*) The chairpersons of the OPAGs on Integrated Observing Systems, on Information Systems and Services, on Data Processing and Forecast Systems, and on Public Weather Services;
   (*d*) Mr Yan Hong (Region II);
   (*e*) Mr R. Sonzini (Region III).

RESOLUTION 4 (CBS-Ext.(98))

OPEN PROGRAMME AREA GROUPS (OPAGs) OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

CONSIDERING that there is a need for the continued development and coordination of the:

(*a*) Surface- and space-based components of the global observing systems,
(*b*) Information systems and services,
(*c*) Data-processing and forecasting systems,
(*d*) Public weather services,

DECIDES:

(1) To establish the OPAG on Integrated Observing Systems with the following terms of reference:
   (*a*) To coordinate all activities related to the surface- and space-based components of GOS, in particular the work of the Expert and Implementation/Coordination Teams and/or rapporteurs established by the Commission under the responsibility of the OPAG, and to liaise and cooperate with the other OPAGs and the Regional Working Groups on the WWW;
   (*b*) To inform members of scientific and technical developments on observing technology and techniques of the surface-based and space-based components of GOS;
   (*c*) To evaluate and advise on the comprehensive observational data requirements of WWW, other WMO and international programmes supported by WMO, and to recommend measures to meet those requirements;
   (*d*) To collect, collate and keep under review the requirements for observations to meet the needs of all WMO Programmes and coordinate recommendations concerning satellite services, related ground-receiving systems and new satellite products;
   (*e*) To improve the utilization of satellite systems by providing guidance on the provision of data products and services from all observation systems, and by assessing the adequacy of related plans of implementation;
   (*f*) To review and advise on the design and implementation of GOS by taking into account established requirements for data as well as cost, capabilities and performance of existing and new observing systems using information received from observing programmes, demonstrations and impact studies;
   (*g*) To review and coordinate monitoring of the operations of the GOS;
   (*h*) To update regulatory and guidance material on the GOS and make recommendations for amendments;

(*i*) To publicize education and training material and recommend training events related to GOS;

(*j*) To monitor progress on the implementation of the current WMO Long-term Plan on matters related to GOS and contribute to the development of the next WMO Long-term Plan, and to the related strategic aims of the Commission;

(*k*) To assure adequate exchange of information between WMO and satellite agencies including the participation in international satellite groups such as CGMS and CEOS;

(2) To establish the OPAG on Information Systems and Services with the following terms of reference:

(*a*) To coordinate all activities related to information systems and services including telecommunications and data management, in particular the work of the Expert and Implementation/Coordination Teams and/or rapporteurs established by the Commission under the responsibility of the OPAG, and to liaise and cooperate with the other OPAGs and the Regional Working Groups on the WWW;

(*b*) To inform members of all relevant developments and requirements relating to telecommunications, data management and the corresponding activities of the ITU and the International Organization for Standardization (ISO);

(*c*) To monitor the operations of the GTS and assess the level of the implementation of new telecommunication, databases and data management techniques, and make proposals regarding the organizational and planning aspects of the GTS and the data management functions, as it relates to WWW, other WMO Programmes, and other international organizations;

(*d*) To plan the implementation of, and make proposals on the organization, technical and operational aspects of the GTS, specifically the MTN, the regional and sub-regional telecommunication networks, as well as meteorological data-collection and distribution systems via environmental observation and communications satellites;

(*e*) To coordinate data management activities supporting the WWW components and other WMO Programmes, including the plans for monitoring the operation of WWW information systems and services;

(*f*) To maintain the existing codes and data representation forms, develop and implement, as required, data representation forms of observational data and products to meet new requirements including those of other WMO bodies and appropriate international organizations;

(*g*) To develop or adjust, as appropriate, meteorological data-management functions including database specifications;

(*h*) To update regulatory and guidance material relating to telecommunications and data management;

(*i*) To publicize education and training material and recommend training events on telecommunications and data-management matters;

(*j*) To coordinate the WMO requirements for, and the allocations of, radio frequency bands and assignments of radio frequencies to meteorological telecommunications, instruments and sensors, both for operational and research purposes through the CBS Steering Group on Radio Frequency Matters;

(*k*) To monitor progress of the implementation of the current WMO Long-term Plan on matters related to telecommunications and data management and contribute to the development of the next WMO Long-term Plan, and to the related strategic aims of the Commission;

(3) To establish the OPAG on Data-processing and Forecasting Systems with the following terms of reference:

(*a*) To coordinate all activities related to the data-processing and forecasting systems, in particular the work of the Expert and Implementation/Coordination Teams or rapporteurs established by the Commission under the responsibility of the OPAG, and to liaise and cooperate with the other OPAGs and the Regional Working Groups on the WWW;

(*b*) To inform members of scientific and technical developments relating to the methods of meteorological analysis and forecasting, to consider the implementation of new techniques, and to coordinate organizational and planning aspects of the GDPS including the requirements, procedures and practices for designating RSMCs;

(*c*) To provide guidance on the use of modern data-processing techniques for meteorological analysis and forecasting including the processing and interpretation of incoming products by NMCs;

(*d*) To coordinate observational data requirements for the production of GDPS products and to provide advice on the formulation of requirements to be met by the GOS;

(*e*) To coordinate existing and new requirements stated by Members, and WMO bodies and appropriate international organizations for WMC and RSMC products and for the production of analysed and forecast data by WMCs and RSMCs;

(*f*) To monitor the performance of the GDPS including the development of procedures for standardized verification of numerical products;

(*g*) To arrange for the provision of products and services by designated RSMCs within the framework of the emergency response activities programme, including the provision of information in support of emergency response in case of nuclear incidents in cooperation with the IAEA, and in support of United Nations humanitarian and relief efforts in cooperation with the corresponding United Nations agencies;

(*h*) To publicize education and training material and recommend training events related to data processing;

(*i*) To monitor progress on implementation of the current WMO Long-term Plan on matters related to the GDPS and the emergency response activity programme, and contribute to the development of the next WMO Long-term Plan and the related strategic aims of the Commission;

(4) To establish the OPAG on Public Weather Services with the following terms of reference:

(*a*) To coordinate all activities related to public weather services, in particular the work of the Expert and Implementation/Coordination Teams and/or rapporteurs established by the Commission under the responsibility of the OPAG, and to liaise and cooperate with the other OPAGs and the Regional Working Groups on the WWW;

(*b*) To help raise the public awareness on the interpretation and use of weather information;

(*c*) To inform members of, and evaluate, technical and scientific developments relating to the formulation, content, presentation and dissemination of weather information and coordinate the related recommendations for application by Members;

(*d*) To establish education and training requirements related to public weather services and make recommendations on how to meet them;

(*e*) To develop guidance material related to public weather services and advice on the overall implementation of the programme;

(*f*) To develop proposals for increasing Members' awareness, preparedness, prevention and response to weather-related disasters;

(*g*) To develop proposals for the verification of end-user products;

(*h*) To coordinate the requirements for the provision of meteorological and hydrological information needed for the mitigation of natural disasters;

(*i*) To improve procedures for the exchange of severe weather warnings between neighbouring countries;

(*j*) To monitor progress on the implementation of the current WMO Long-term Plan on matters related to the Public Weather Services Programme and contribute to the development of the next WMO Long-Term Plan and to the related strategic aims of the Commission;

(5) To select, in accordance with General Regulation 32:

(*a*) Mr J. Purdom (United States) as chairperson of the OPAG on Integrated Observing Systems;

(*b*) Mr G. Hoffman (Germany) as chairperson of the OPAG on Information Systems and Services;

(*c*) Ms A. Simard (Canada) as chairperson of the OPAG on Data-processing and Forecasting Systems;

(*d*) Mr K. Essendi (Kenya) as chairperson of the OPAG on Public Weather Services;

REQUESTS:

(1) The chairpersons of the OPAGs to act upon matters referred to the OPAG by the president of CBS;

(2) The chairpersons of the OPAGs, in collaboration with the president of CBS, to consider the need to establish vice-chairpersons of their OPAGs;

(3) The chairpersons of the OPAGs to submit a report to the Commission not later than three months prior to its session, and specifically the chairperson of the OPAG on the Integrated Observing Systems, through the president of CBS, a report on matters of operational importance relating to satellite activities annually to the Executive Council under the WWW Programme.

RESOLUTION 5 (CBS-Ext.(98))

REVIEW OF THE PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS

THE COMMISSION FOR BASIC SYSTEMS,

NOTING the action taken on the resolutions and recommendations adopted by the Commission prior to its extraordinary session,

DECIDES:

(1) To replace Resolutions 1, 2, 3, 4, 5, 6, 7 and 8 (CBS-XI) with new resolutions;

(2) To keep in force Resolution 10 (CBS-97) — Steering Group on Radio Frequency Coordination, and Recommendation 10 (CBS-98) — Amendments to code tables;

(3) Not to keep in force the other resolutions and recommendations adopted before its extraordinary session.

RECOMMENDATIONS ADOPTED BY THE SESSION

RECOMMENDATION 1 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-No. 544) — VOLUME I, PART III

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The *Abridged Final Report with Resolutions and Recommendations of the Eleventh Session of the Commission for Basic Systems* (WMO-No. 854), general summary paragraphs 6.1.25 and 6.1.26,

(2) The report of the seventh session of the CBS Working Group on Observations (Geneva, October 1997),

(3) The report of the fourth session of the Atmospheric Observation Panel for Climate (AOPC-IV, Hawaii, April 1998),

CONSIDERING the need to provide those Members implementing GCOS upper-air and surface stations with the sets of "best practices" to enhance the value of the observations for climate purposes,

RECOMMENDS that the *Manual on the Global Observing System* (WMO-No. 544), Volume I, Part III be amended as indicated in the annex to this recommendation to take effect as from 1 July 1999.

ANNEX TO RECOMMENDATION 1 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL OBSERVING SYSTEM* (WMO-NO. 544) VOLUME I, PART III

Insert new section 2.10.3.17

2.10.3.17 Best practices for Global Climate Observing System surface network stations

2.10.3.17.1 Members should implement the GCOS surface network — the global reference network of some 1 000 selected surface observation stations established with a density of approximately one station per 250 000 square kilometers to monitor daily global and large-scale climate variability.

2.10.3.17.2 In implementing the observing programme at GSN stations, Members should comply with the following best practices:

(*a*) Long-term continuity should be provided for each GSN station: This requires the provision of the necessary resources, including well-trained staff, and keeping changes of location to a minimum. In the case of significant changes in sensor-devices or station location, Members should provide for a sufficiently long period of overlap (at least one but preferably two years) with dual operation of old and new systems to enable comparisons to be made and the identification of inhomogeneties and other measurement characteristics;

(*b*) CLIMAT data should be provided in an accurate and timely manner: CLIMAT reports should be transmitted by the fifth day of the month but not later than the eighth day of the month;

(*c*) Rigorous quality control should be exercised on the measurements and their message encoding: CLIMAT reports require quality control of the measurements themselves and their message encoding to ensure their accurate transmission to national, regional and world centres for their use. Quality-control checks should be made on site and at a central location designed to detect equipment faults at the earliest stage possible. The *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8) provides the appropriate recommendations;

(*d*) The site layout should follow the recommended form: The layout of the site should follow the recommendations in the *Guide on the Global Observing System* (WMO-No. 488);

(*e*) The site and instruments should be inspected regularly and maintained according to WMO recommended practices: To obtain homogeneous datasets, maintenance should be carried out as is documented in the *Guide to Meteorological Instruments and Methods of Observation* (WMO-No. 8). The quality of the measured variables should be guaranteed by appropriate inspection of sites, instruments and exposure to be based on the procedures given in the *Guide*. As part of the maintenance, the necessary calibration practices should be

traceable to the standards provided by the *Guide*;

(*f*) A national plan should be developed to archive daily data from GSN stations for climate and climate research purposes: The archive should include both observational data and metadata pertaining to each climate station. Metadata should include data concerning a station's establishment, subsequent maintenance, and changes in exposure, instrumentation and staff. The data and metadata should be in its original form as well as digital format;

(*g*) Detailed metadata and historical climate data for each GSN station should be provided: A GSN Data Centre should have an up-to-date digital copy of the historical climate data and all types of metadata for GSN stations. A current copy of the long-term series of data and metadata from GSN stations should be made available.

Insert new section 2.10.4.9 as follows:

2.10.4.9 Best practices for the Global Climate Observing System upper-air network stations;

2.10.4.9.1 The Members should implement the GCOS upper-air network (GUAN) — the global baseline network of about 150 selected upper-air stations established with relatively homogenous distribution to meet requirements of GCOS.

2.10.4.9.2 In implementing observing programmes at GUAN stations, Members should comply with the following best practices:

(*a*) Long-term continuity should be provided for each GUAN station: This requires the provision of the necessary resources, including well-trained staff, and keeping changes of location to a minimum. Changes of bias caused by changes in instrumentation should be evaluated by a sufficient overlapping period of observation (perhaps, as much as a year) or by making use of the results of instrument intercomparisons made at designated test sites;

(*b*) Soundings should preferably be made twice per day and should reach as high as possible, noting the GCOS requirements for ascents up to a height of 5hPa. Since climate data are needed in the stratosphere to monitor changes in the atmospheric circulation and to study the interaction between stratospheric circulation, composition and chemistry, every effort should be made to maintain soundings regularly up to a level as high as possible noting the above GCOS requirement;

(*c*) CLIMAT TEMP data should be provided in an accurate and timely manner: CLIMAT TEMP reports should be transmitted by the fifth day of each month, but not later than the eighth day of the month;

(*d*) Rigorous quality control should be exercised at each GUAN site: Periodic calibration, validation and maintenance of the equipment should be carried out to maintain the quality of the observations;

(*e*) Basic checks should be made before each sounding to ensure accurate data: The accuracy of a radiosonde's sensors should be checked in a controlled environment immediately before the flight. Checks should also be made during and/or at the end of each sounding to assure incomplete soundings, or soundings containing errors are corrected before transmission;

(*f*) Back-up radiosondes should be released in cases of failure: In the event of failure of a sounding instrument, incomplete sounding or resulting from difficult weather conditions, a second release should be made to maintain the record from the GUAN station;

(*g*) Detailed metadata for each GUAN station should be provided: The batch identifier on the radiosondes should be logged for each flight, so that faulty batches can be identified and the data amended or eliminated from the climate records, if necessary. Up-to-date records of metadata in a standard format should be provided to the GUAN Data Centre so that shifts in the data will not be mistaken for climate change. The metadata should include detailed information about the station such as location, elevation, operating instruments and their changes over time. Changes to operating and correction procedures should also be recorded. Both the corrected and uncorrected upper-air observation should be archived. Climate change studies require extremely high stability in the systematic errors of the radiosonde measurements.

RECOMMENDATION 2 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I, GLOBAL ASPECTS, PARTS I, II AND III

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) Resolution 2 (Cg-XII) — World Weather Watch Programme,

(2) The *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I, Global Aspects, Parts I, II and III,

RECOMMENDS that the *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I, Global Aspects, Parts I, II and III be amended as given in the annex to this recommendation, with effect from 1 November 1999;

REQUESTS the Secretary-General to make the amendments as given in the annex to this recommendation to the *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I, Global Aspects, Parts I, II and III;

AUTHORIZES the Secretary-General to make any consequent purely editorial amendments of the *Manual on the Global Telecommunication System* (WMO-No. 386), Volume I.

ANNEX TO RECOMMENDATION 2 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL TELECOMMUNICATION SYSTEM* (WMO-No. 386), VOLUME I

PART I

Add in paragraph 2.1 an additional item (*h*):

(*h*) Maintaining the Catalogue of Meteorological Bulletins as regards bulletins issued from the zone for which they are responsible for the collection, exchange and distribution of data, as given in paragraph 1, Attachment I-3, and also including data from the Antarctica, as appropriate. WMCs/RTHs on the MTN may share their responsibility with the RTHs (not on the MTN) included in their zone of responsibility through regional arrangements.

PART II

Replace the text of paragraph 2.7.1 to read:

The length of messages should be determined according to the following guidelines:

(*a*) WMO messages for transmission on the GTS shall not exceed 15 000 octets, with the exception of coded digital facsimile products;

(*b*) Sets of information, transmitted using segmentation into a series of bulletins, shall not exceed 250 000 octets;

(*c*) The existing limit of 3 800 octets on alphanumeric messages shall be increased to 15 000 octets on 6 November 2000;

(*d*) Sets of information may be exchanged using the file transfer technique described in Attachment II-15, particularly where sets larger than 250 000 octets are concerned.

Add in Attachment II-5 the following note in Table A, right hand column "Max length****":

**** The existing limit of 3 800 octets on alphanumeric messages shall be increased to 15 000 octets on 6 November 2000 (see paragraph 2.7.1)

Add a new section 2.10.3, including revised Attachment II-7:

2.10.3 Routeing catalogues

2.10.3.1 The procedures described here are recommended for the exchange of the Routeing Catalogues of GTS Centres. The routeing catalogue is exchanged in the form of a file which can be directly ingested into most database software packages to help in GTS data flow analysis. The files containing "Routeing Catalogues" should be obtained using FTP file transfer over the Internet where possible and should be either available at each Centre or from the WMO server. The WMO server should contain a list (with hyperlinks) of all Centres who have routeing catalogues available for exchange. All Centres should provide the WMO Secretariat with URL addresses of where their respective files are located.

2.10.3.2 The routeing catalogue of a GTS centre should provide the following information for each bulletin identified by its abbreviated heading TTAAii CCCC:

(*a*) The GTS circuit on which the bulletin is received;

(*b*) The list of the GTS circuits on which the bulletin is sent.

2.10.3.3 Each RTH should prepare a routeing catalogue and make it accessible by the other GTS centres, in particular by its associated NMCs. The routeing directory should be updated monthly if possible, but not less than every three months.

2.10.3.4 A GTS centre should include in its routeing catalogue the abbreviated headings of all bulletins received and/or transmitted on any GTS circuit connected to this GTS centre (GTS point-to-point circuits, GTS point-to-multipoint circuits such as satellite distribution systems, including the remaining HF broadcasts). Any bulletin scheduled to

be received by the GTS centre, even if not actually forwarded on the GTS, should be included in the routeing catalogue.

2.10.3.5 The bulletins received and/or transmitted on a circuit established under a bilateral agreement for meteorological data exchange should also be included in the routeing catalogue.

2.10.3.6 The format of the routeing catalogue and the procedures for the access to the routeing catalogues are given in the Attachment II-7.

Renumber paragraph 2.10.3 as 2.10.4.

Replace paragraph 2.12.1 to read:

2.12.1 The transmission protocols for use on the GTS shall be elements of procedures as specified in ITU-T Recommendation X.25 and the Transmission Control Protocol/Internet Protocol (TCP/IP).

Delete paragraph 2.12.2 and renumber the paragraphs that follow accordingly.

Insert in paragraph 2.12.2.3 (old 2.12.3.3), fourth subparagraph, last sentence, the following sentence:

The recommended procedures for the use of VCs — also called switched virtual circuits (SVCs) — are given in Attachment II-14.

Amend paragraph 2.12.3 (old 2.12.4) to read:

2.12.3 TCP/IP protocol

The recommended practices and procedures for the implementation, use and application of the Transmission Control Protocol/Internet Protocol (TCP/IP) on the GTS are as given in Attachment II.15.

Replace Attachment II-7 by new text, as follows below.

Insert new Attachments II-14 and II-15, which follow below.

ATTACHMENT II-7

ROUTEING CATALOGUES

1. Format of the routeing catalogue

1.1 The routeing catalogue should be produced as an ASCII file, which could be imported into database applications. The information should therefore be presented in a database structure. The hereunder structure allows an easy display on a screen, e.g. using a "view" command.

1.2 The file containing the routeing catalogue of a GTS centre should be named: CCCCROCA.TXT, where CCCC is the location indicator of the centre. The date of the preparation of the catalogue should be inserted in the first line of the line as YYYYMMDD (where YYYY is the year, MM the month and DD the day).

1.3 For each abbreviated heading, a record should comprise the following fields:

Field number	*Content*	*Width*
1	Abbreviated heading TTAAii CCCC	11
2	GTS circuit from which the bulletin is received (see paragraph 1.4)	4
3	GTS circuit to which the bulletin is sent (see paragraph 1.4)	4
As many additional fields in the format of field No. 3 as additional circuits to which the bulletin is sent.		

1.4 The following combination of four characters should be used to designate the GTS circuits and entered into fields No. 2, 3 and subsequent fields:

(*a*) When the GTS circuit is a the unique point-to-point circuit connecting the GTS centre to an adjacent centre, the location indicator CCCC of the relevant adjacent GTS centre should be used;

(*b*) In other cases, e.g. when the circuit is a point-to-multipoint circuit (e.g. a satellite distribution system), a specific CCCC combination should be used, for example using a combination of letters and figures to differentiate them from the usual location indicators CCCC; the description of the relevant GTS circuits may be given in the file CCCC RMKS.TXT (see paragraph 2).

In the combination of characters CCCC, wild cards "*" should only be used when the GTS centre cannot provide complete information. The use of wild cards is not recommended, since it limits the information.

1.5 The fields should be surrounded by quotes and separated by commas.

Sample of structure:

"SMAA01 EGRR","RJTD","ANOU","DEMS",
"NFFN","NTAA","NZKL","PMBY"
"SMAA01 EGRR","KWBC","NZKL"
"SMAA10 KWBC","EGRR","DEMS","NFFN",
"NTAA","NZKL","WIIX"

2. Additional information

Any additional information, such as the creation dates of the directory, details of any extra CCCCs included in the routeing catalogue, the means and procedures to access the routeing catalogue (e.g. FTP server) and any other information which may help users should be included in a file named: CCCC RMKS.TXT, where CCCC is the location indicator of the centre.

3. Access to the routeing catalogues of RTHs

3.1 Each RTH should make available its own routeing catalogue on the FTP server, which it operates. The files from each centre should be found under GTS_routeing/CCCC subdirectories on all servers. When an RTH does not have the capacity to make its routeing catalogue available on a local server, it should transfer its routeing catalogue CCCCROCA.TXT into the WMO FTP server under the sub-directory GTS_routeing/CCCC, preferably by direct access to the WMO FTP server or by sending diskettes to the Secretariat.

3.2 RTHs should transfer their files CCCC RMKS.TXT into the WMO FTP server (www.wmo.ch) under the sub-directories GTS_routeing/ CCCC, where CCCC is the location indicator of the RTH. Each sub-directory GTS_routeing/CCCC is reserved for each RTH, which may transfer and update the data as required. Each RTH should transfer its CCCCRMKS.TXT into the WMO FTP server, preferably by direct access to the WMO FTP server or by sending diskettes to the Secretariat. By accessing the information included in the files CCCCRMKS.TXT available in the WMO FTP server, the GTS centres should find information on the means and procedures to access the routeing directories of any RTHs.

3.3 RTH Offenbach operates on its own FTP server, a mirror site of the part of the WMO FTP server related to the routeing catalogues.

ATTACHMENT II-14

USE OF X.25 SWITCHED VIRTUAL CIRCUITS (SVCS)

The X.25 virtual calls, also called switched virtual circuits (SVC), are used on the GTS. The X.25 SVCs can be used in a pure X.25 environment or in conjunction with other communications protocols such as TCP/IP. In all cases, the use of SVCs has the following advantages over permanent virtual circuits (PVC):

(*a*) Reduces data loss on circuits with packet switches;
(*b*) Enables backup circuits to be operated with minimum disruption;
(*c*) Allows flexible data exchange via negotiation of packet size, window size, throughput class, etc.

The following sections describe the typical uses and configuration characteristics of X.25 SVCs on the GTS. Basic recommendations for the implementation of X.25 SVCs are also given.

1 Pure X.25

1.1 Traffic type

Traditional MSS traffic, i.e. continuous routine messages.

1.2 Configuration characteristics

A pure X.25 SVC connection may be treated as either:

(*a*) A constant X.25 connection between centres which is operated in a similar manner to that of a PVC;
(*b*) A transient X.25 connection between centres.

1.3 Recommended operation

1.3.1 Traffic flow

As the operation of individual SVCs for incoming and outgoing traffic is easier to control and less ambiguous to implement on the MSS, it is recommended that the traffic flow on a X.25 SVC be one-way. In this case, a transmitting centre initiates the X.25 call set-up to establish an SVC for its outgoing traffic.

1.3.2 X.25 Call clearing

SVCs may be either:

(*a*) Kept open wherever possible;
(*b*) Cleared down on an inactivity timer by either centre.

The former is the simplest approach to exchange routine messages on a leased circuit as it is similar to a PVC connection. However, the latter may provide a desirable solution in such conditions as the use of public data networks or existence of packet switch restrictions. It is recommended that the chosen option be agreed on a bilateral basis.

2 IP over X.25

2.1 Traffic type

Data not traditionally associated with a MSS, (e.g. satellite imagery), exchanged intermittently on real-time basis — usually via FTP. Data is typically transmitted in bursts.

2.2 Configuration characteristics

2.2.1 The X.25 SVC is typically intermittent between adjacent centres.

2.2.2 Specific connection details (e.g. the number of SVCs allowed, an idle timer for call clearing) may be dependent on router brand and configuration.

2.3 Recommended operation

The routers provide flexible functions to handle the X.25 call set-up and call clearing in the case of both one-way and two-way traffic on an SVC. As the data tends to be transmitted in bursts it is undesirable that unnecessary SVCs remain for a long period. It is therefore recommended that an idle timer for call clearing in routers be configured for efficient operation.

3 X.25 over IP

3.1 Traffic type

Traditional MSS traffic, i.e. continuous routine messages.

3.2 Configuration characteristics

3.2.1 The X.25 may be a constant or transient connection between adjacent centres.

3.2.2 There is no standard for X.25 over IP.

3.3 Recommended operation

The recommended operation for the X.25 based portion is as in section 1.3.2. As no standard exists for X.25 over IP this solution is router specific. Therefore any router and router configuration must be adopted bilaterally.

It should be noted that IP over X.25 and X.25 over IP are not as efficient as pure X.25 or pure IP. While IP over X.25 is standardized (with the associated advantages this gives) centres may wish to move to using X.25 over IP or pure IP if the amount of IP traffic becomes significant as the more IP has to be encapsulated within X.25 the less efficient the link will become.

ATTACHMENT II-15

RECOMMENDED PRACTICES AND PROCEDURES FOR THE IMPLEMENTATION, USE AND APPLICATION OF TCP/IP ON THE GTS

FOREWORD

The strategic direction for development of the GTS, as endorsed by CBS, has since the early eighties, been based on the open systems interconnection (OSI) standards, especially the ITU-T recommendation X.25. However, CBS now considers that the TCP/IP protocols as used on the Internet, should replace X.25 for supporting GTS operations in the future.

The change in strategic direction has evolved within CBS in recent years. It has occurred for various reasons, including the expanding functional needs of the various WMO Programmes and the evolution of the Internet and its supporting technical standards, as a dominant force in the information technology industry, supplanting the OSI standards in many areas.

The transition to TCP/IP is considered appropriate because:

(*a*) Vendor support for X.25 technology is declining and becoming more expensive due to industry concentration on TCP/IP;

(*b*) TCP/IP supports numerous application utilities available off the shelf, which offer solutions to information communications needs of Members, such as file transfer, Web browsers, electronic mail and future applications such as multimedia communications;

(*c*) TCP/IP provides connectivity between Members in a more flexible and versatile manner than the X.25-based equivalent.

These benefits equate to direct savings in financial and human resource costs to Members by:

(*a*) Reduced costs for communications equipment purchase and maintenance; and

(*b*) Reduced software development work through use of industry standard software systems.

Considerable efforts have been applied in defining the framework for applying TCP/IP to the GTS and for the orderly transition from the OSI/X.25-based origin of the GTS. In particular, this attachment on the use of TCP/IP on the GTS has been produced.

Procedures are defined to ensure that the primary function of the GTS in carrying real time operational traffic with minimum delay is preserved. The issue of securing the GTS from interference via the Internet is also addressed in general terms. Reliance must however be placed on all Members with a TCP/IP-based connection to the GTS, who are also connected to the Internet, to implement and maintain thorough security practices.

Members are strongly advised to take account of the adoption of the TCP/IP-based strategy for the future development of the GTS, in planning the future development of systems within their national Centres.

1. Introduction

Historical perspective

The GTS at present is predominantly used to support the message switching application using message exchange in WMO format over a limited OSI transport service based on point to point X.25 supplemented by broadcasts. This limited implementation has been adequate for the legacy application of message switching but is not capable of meeting new requirements for support of various WMO Programmes, especially WWW as developed within CBS. These requirements include support for:

(*a*) Distributed databases (DDB);

(*b*) Data exchange between non adjacent centres;

(*c*) Exchange of information that cannot readily be handled by message switching systems (MSSs).

The full list of requirements to be fulfilled by the Main Telecommunications Network (MTN) of the GTS were agreed upon by CBS-Ext. 1994. The use of TCP/IP services was endorsed by CBS-Ext. 1994 as a means of fulfilling these new requirements.

Purpose of this attachment

This attachment is intended to assist Centres to implement TCP/IP-based services on the GTS. The aim of this attachment is to describe those aspects of the application of TCP/IP that apply specifically to the GTS to meet new requirements and also the long established routine data exchange undertaken by message switching systems (MSSs). The attachment takes account of the technical evolution of the GTS from an X.25-based network, and maintains the philosophy that Centres continue to be autonomous as far as possible, recognizing that the timing for implementation of new systems is determined by individual Members in the light of their available resources and relative priorities.

This attachment does not cover fundamentals of TCP/IP but focuses on those aspects that are essential for successful application on the GTS. Such aspects include appropriate use of the GTS compared with the Internet, IP and X.25 addressing, router management, TCP/IP application services (such as FTP) and fault management. The attachment also does not attempt to address security issues and practices, this being a complex subject in itself. Some references on TCP/IP and on computer security are given in Appendix 3.

Relationship of the Internet and GTS

The recent and rapid emergence of the Internet poses issues to be decided as regards its role in relation to the GTS in meeting operational communications requirements of National Meteorological Services. The

Internet has grown rapidly in capacity, penetration and diversity of applications. Its bandwidth greatly exceeds that of the GTS and it could potentially take over some functions of the GTS. The weakness of the Internet, as of 1998, is that its performance from day to day, even hour to hour is unpredictable due to its variable and rapidly growing traffic load. Furthermore its availability at various Centres differs in reliability and capacity. For some centres it is quite possible that the absolute level of Internet performance can be unacceptably low. We must assume therefore that there will remain a need for a separate GTS and plan accordingly.

The attachment is based therefore on the assumption that the GTS with its limited but assured capacity will continue to be required for essential exchange between WMO Members. It should however, where appropriate, adopt Internet technology to improve versatility and maximize the scope for using standard software tools and services for the exchange of data and information. The limited capacity of the GTS creates a need for a practice of 'acceptable' use and for it to be engineered in such a way that it is protected from general Internet traffic and preserves security against inappropriate use and unauthorized access. In particular, the use of IP on the GTS will have to be managed in such a way as to allow communication between non-adjacent Centres only with the knowledge and concurrence of all intermediate Centres. Otherwise there is a danger that large amounts of GTS capacity could be consumed by non-routine traffic, to the detriment of real-time operational data exchange.

Evolution of the GTS

The use of the ISO/ITU standard X.25 was adopted by WMO in the early 1980s to facilitate the exchange of data and products encoded in WMO binary code forms (GRIB, BUFR, etc.) and to act as a base for higher level OSI applications that would emerge at a later date. OSI being regarded at the time as the strategic direction for the evolution of data communications. Since then, X.25 at OSI layers 2 and 3 has been implemented on much of the GTS and virtually all of the MTN. The implementation has been predominantly one of PVCs directly linking the MSSs of Members. There has been some movement towards SVCs as a result of the strategic deployment of packet switches by some centres as the first move towards making the GTS more of a true network and less of a series of bilateral links. Such a strategy could be pursued but the emergence of the Internet and TCP/IP networking offers an alternative that appears much more attractive, particularly for non-MSS requirements.

The evolution of the GTS to adopt TCP/IP is now appropriate because:

(*a*) It has become the dominant protocol suite in everyday use being now packaged with virtually all implementations of Unix and many PC operating systems such as Windows 95 and NT;

(*b*) It offers a wide range of standard applications (file transfer, electronic mail, remote logon, World Wide Web, etc.) that will greatly reduce the need for the WMO community to develop special procedures and protocols as it has had to be done in the past;

(*c*) It provides useful features such as automatic alternate routing (in a meshed network) which could improve the reliability of the GTS.

This attachment however takes account of the fact that centres have based plans and developed systems in line with the OSI standards, particularly X.25, as endorsed by WMO and specified in the *Manual on the Global Telecommunication System* (WMO-No. 386). The adoption of TCP/IP-based services must be implemented in an orderly transition from the X.25-based links in such a way that operation of the GTS is not disrupted or put at risk.

The attachment provides for this by defining procedures for:

(*a*) An interim hybrid based on:
  - (i) Carrying TCP/IP-based services over an X.25 network service; or
  - (ii) carrying X.25 data over IP-based network service via directly connected routers;

(*b*) Subsequent transition to pure IP utilizing directly-connected routers, together with TCP/IP-based application services, such as TCP sockets or file transfer protocol (FTP).

The transition to the second step (pure IP) is desirable because:

(*a*) Operating TCP/IP over X.25 may not provide expected throughput because of router processing overheads involved in packet encapsulation of IP frames within X.25 packets. This appears to become worse as line speed increases. Limited tests which have been done between Centres in Region VI indicate efficiency less than 50 per cent at 64 Kbps;

(*b*) The management and maintenance activities required for the X.25 network and associated packet switches can be avoided;

(*c*) Carrying X.25 over IP requires the use of proprietary features of specific router brands.

In order to move to pure IP, it is necessary to modify MSSs at each Centre to make use of TCP/IP services such as FTP and sockets. This is covered in some detail in section 4.

Other related issues

Many centres have experience of TCP/IP but generally in areas away from the GTS, although there is some limited use of TCP/IP for message/file exchange on the GTS. The main technical issues, which need to be addressed to establish widespread use of TCP/IP on the GTS, are:

(*a*) Agreed methods for the message switching application to use TCP/IP either directly or via higher level applications, e.g. FTP;

(*b*) An agreed file naming convention and standard for metadata associated with files;

(*c*) A community-wide naming and addressing agreement.

It is the aim of this attachment to make some progress with these issues, some of which lie in the domain of data management as much as of telecommunications. It must also be recognized that the existing GTS is not a true network, but rather a collection of discrete point-to-point links. Widespread adoption of TCP/IP will start to create a true network, which will, in turn, raise difficult issues with regard to the management and funding of shared resources. Such management issues are beyond the scope of these guidelines.

2. Principles governing the use of TCP/IP on the GTS

MANAGEMENT OF TRAFFIC ON GTS AND INTERNET

The TCP/IP protocol suite provides the potential to use the full range of TCP/IP applications on the GTS. Some applications, such as file transfer and the World Wide Web, have potential to place heavy loads on the limited bandwidth circuits that comprise the GTS. Limits need to be applied to ensure that the GTS carries only important traffic such as the real-time data and products currently exchanged on the GTS plus data to be carried to fulfil new requirements such as DDBs, and routinely exchanged large data files such as satellite imagery. Less important traffic such as ad hoc file exchange, e-mail, general World Wide Web and suchlike should be carried on the Internet. To protect the GTS, the full capabilities of TCP/IP connectivity and information exchange must be restricted. In practical terms, TCP/IP traffic carried on the GTS could be restricted on the basis of:

(*a*) Protocol type (e.g. FTP, HTTP, SMTP etc);
(*b*) Originating and destination IP address;
(*c*) A combination of the above.

If the measures adopted are to be successful, it is necessary that they:

(*a*) Are not confined to a single router brand since it cannot be assumed that all centres will have the same brand of router; and
(*b*) Be reasonably straightforward to configure, so that there is minimum risk that configuration errors or omissions will endanger the GTS.

After considering these factors, the approach recommended is that only a small number of selected hosts in each Centre (e.g. the MSSs) be allowed to use the GTS, with no restriction placed on the protocol type. The concept is illustrated in Figure 2.1. Host A_{NMC1} and A_{NMC2}, are "GTS-designated" hosts. They are allowed to exchange traffic on the GTS using any TCP/IP protocol.

Hosts $B_{NMC1}$and B_{NMC2} represent all other hosts in the two Centres which are not "GTS designated". They must communicate via the Internet.

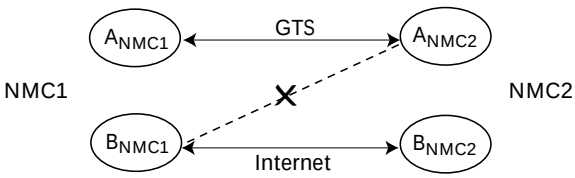


Figure 2.1 — Connectivity between hosts in GTS Centres.

To achieve this functionality, the site manager at each Centre must nominate which hosts are allowed to use the GTS. The GTS routers in each Centre must be configured so as to advertise only routes to "A" hosts, with packet filtering set to block packets from and to "B" hosts. A consequence of this is that A_{NMC2} will be unable to communicate with B_{NMC1} (and vice versa) even though both "A" and "B" hosts can access the Internet at large.

The actual configuration details to invoke the above functions in the Cisco family of routers are given in Appendix 1.

As a further precaution to protecting the GTS from traffic overload, the "A" hosts in a non-adjacent Centre should only be permitted to communicate with the knowledge and concurrence of intermediate Centres.

SEGREGATION OF INTERNET AND GTS TRAFFIC

Any Centre which has a TCP/IP-based GTS connection and a connection to the Internet, is a potential weak point where the GTS could be exposed to interference deliberately or inadvertently through unwanted traffic or unauthorized connection to GTS hosts.

Centres are strongly encouraged to implement protective barriers such as firewall systems on the connection of their Centre with the Internet. It is important that every practical step is taken to prevent accidental or deliberate use of GTS links or unauthorized access to GTS Centres, by Internet users.

When setting up IP on the GTS, it is vital to ensure that the GTS does not become part of the Internet. Each Centre must consider the GTS and the Internet as two separate networks and must ensure that inappropriate flow of traffic from one to the other cannot occur. This will ensure that the GTS is used only for transferring operational meteorological data between authorized hosts.

Some basic principles for maintaining minimum segregation of GTS and Internet traffic are shown in Figure 2.2 below. It illustrates in a general way, how a Centre with TCP/IP connection to the GTS and an Internet connection might be set up. Functions to be implemented include:

(*a*) Allowing only GTS designated hosts to communicate through the GTS router;
(*b*) Blocking access to GTS designated hosts through the firewall and Internet router;

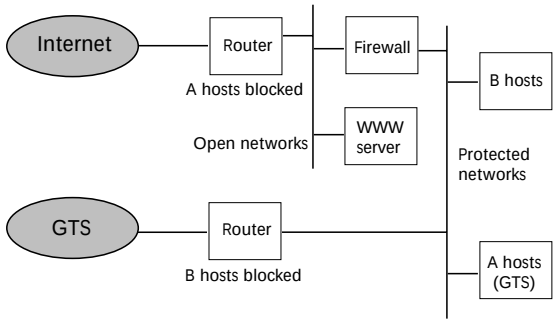


Figure 2.2 — Generic arrangement for protecting GTS systems.

(*c*) Firewall allows only approved hosts on the Internet to access B hosts and then, only for approved applications, such as FTP;
(*d*) Prevention of access to A hosts from Internet via B hosts.

The actual choice of routers and firewall and the setting up of these will require expertise in the design and configuration of networking and security systems. In addition, it is vital that good security practices are followed in the management of all hosts in a Centre. Computer security is a complex subject in itself and Centres are encouraged to study this in depth and apply appropriate practices. Some references in computer security are given in Appendix 3. As a bare minimum, good password practices should be followed in the management of all host machines in a Centre. Some recommended practices are given in Appendix 4.

ROUTING AND TRAFFIC MANAGEMENT

Routing algorithms

In order to be able to send a packet, every host, router or equipment connected on an IP network must have a routing table. The table tells the system where to send the packet. This may be achieved by:
(*a*) Static routing; or
(*b*) Dynamic routing.

STATIC ROUTING

With static routing, every required destination and next hop must be entered in the routing tables by the system administrator. Alternatively, a default route can be declared, although this option is mainly applicable to sites with only one connection to the outside world. If a default route is set up, filters must be established to ensure that only authorized hosts can access the GTS.

Whenever a new Centre is connected to the GTS with IP protocol, the site managers of all other IP capable Centres must add the new address to their routing tables. This might become a major task as IP connectivity spreads over the GTS.

DYNAMIC ROUTING

With dynamic routing, the routing information is automatically exchanged between routers. This enables the network to learn new addresses and to use alternative paths under fault conditions in a partially meshed network topology. The initial set-up of dynamic routing may be somewhat more complex, but the ongoing management task is greatly reduced.

Use of dynamic routing requires selection of an agreed routing protocol to operate over the links of the GTS. Two exterior gateway protocols are defined by RFCs — EGP and BGP (now release 4 — RFC 1654). As the GTS is not a tree structure, setting up routing with EGP may be difficult. BGP 4 does not suffer topological constraints. It is more powerful, but a little more difficult to configure.

BGP can distribute subnetted routes. This feature might be very useful for the GTS. Instead of propagating host-based routes or full network routes, routing can be based on subnetted networks. Instead of declaring hosts eligible to use the GTS, a Centre could declare a full subnet of eligible hosts. In that case, the routing information consists of just an IP address and a subnet mask. For example, if a Centre has a class C addresses 193.168.1.0, by declaring that the subnet 193.168.1.16 with mask 255.255.255.248 is allowed to use the GTS, all hosts with IP address 193.168.1.17 to 193.168.1.22 will be routable on the GTS.

Recommended routing method

Based on consideration of the above factors the BGP4 routing protocol should be used between Centres on the GTS, unless an alternative is bilaterally agreed on individual links. Examples of BGP4 set-up for the Cisco router family are given in Appendix 1.

Summary of tasks to ensure proper use of IP on the GTS

1. Use only official IP addresses.[1]
2. Declare which IP addresses in your Centre are eligible to use the GTS. (A list of allowed hosts and/or subnets is kept on the WMO FTP server.)
3. Establish an IP connection with one or more Centres. This connection will be either pure IP using PPP as a level 2 protocol on the link, or either IP over X.25 (RFC 1356). In this case, use X.121 addresses as defined in section 3.
4. Configure dynamic routing with BGP (unless you are a Centre with only one GTS connection and have agreed with your neighbouring Centre to use static routing).
5. Obtain an autonomous-system number (you can either use an official AS number obtained from the NIC or an unofficial one through the WMO Secretariat which will maintain a list of AS numbers used on the GTS) to be advertized only through BGP eligible hosts and/or subnets.
6. Check the barrier between Internet and the GTS (prevent routing from the Internet to the GTS).
7. Filter incoming and outgoing traffic in accordance with the requirements described above.

3. Implementation guidelines

Introduction

The introduction of IP-based services on the GTS will in many cases, be implemented initially by using a mixture of X.25 and IP, because of the technical evolution of the GTS as described in section 1. IP services may be carried over an X.25 network by encapsulating IP packets within X.25 packets. An appropriately configured router at each GTS Centre carries out this function. Alternatively, where routers of the same brand are used

1 Official IP address could be obtained via national and/or regional Network Information Centres (NIC).

in adjacent Centres, X.25 data may be carried on an IP link using X.25 switching capability of the routers.

It is desirable ultimately for Centres to adopt through bilateral agreement, direct IP connections with TCP/IP application services (FTP, Sockets) superseding IP over X.25, or X.25 over IP as the case may be.

It is necessary to have an addressing framework for:

(*a*) X.25 packet switching between Centres;
(*b*) IP over X.25;
(*c*) direct IP (including X.25 over IP).

Addressing for X.25 packet switching between Centres

Many centres have adopted X.25 for point-to-point connections between message switching systems (MSS). A number of Centres have installed, or plan to install packet switches to provide capability for connections between non-adjacent Centres. An addressing scheme has been developed for this purpose and has been adopted by WG-TEL (thirteenth session, 1994). It is a 14-digit scheme of the form:

0101xxxiiyyyzz, where:

- 0101 is a pseudo DNIC which does not correspond to any actual DNIC and therefore will ensure that calls cannot be mistakenly switched to any network other than the GTS;
- xxx is the X.121 country code of the Centre;
- ii is a protocol indicator, being 00 for MSS, 11 for TCP/IP, 22 for OSI CONS, 33 for OSI CLNS;
- yyy is the nationally-assigned port number;
- zz is the nationally-assigned sub-address number;

This addressing scheme is to be used for setting up virtual calls (VCs) for MSS applications and for any other GTS applications including carriage of IP traffic over X.25.

Addressing for IP over X.25

In order to carry IP traffic over X.25, two globally coordinated address schemes are necessary:

(*a*) An X.25 scheme as described above; and
(*b*) An IP address scheme to apply to the interface between the router and packet switch to enable the router to encapsulate the IP packets into X.25 packets. The general arrangement is shown in Figure 3.1.

For IP over X.25 to function correctly, it is necessary for the underlying X.25 network to be allocated a single IP network address and for each Centre to have an address within this network for the connection point between its router and its packet switch. The Class C network address 193.105.177.0 has been allocated for this purpose, by agreement between *Météo-France* (the registered holder of this address) and WMO. Each IP node on the network will be assigned a sequential host address within this single Class C IP address as illustrated in Figure 3.1. The Class C address can provide for 254 Centres to be connected using a subnet mask of 255.255.255.0.

The routers at each centre have to be set up so that they issue an X.25 call request to the X.25 port of the final destination Centre. This means that IP traffic passes through the packet switch only, and not the router of the intermediate Centre.

Addressing for direct IP

At an appropriate future time, Centres may wish to replace IP over X.25 with direct IP links with neighbouring Centres under bilateral agreement. This transition would be appropriate when the volume of IP traffic predominates and the MSSs are capable of communication using TCP/IP. A further seven Class C network addresses have been allocated for direct IP links between Centres, by agreement between *Météo-France* (the registered holder of these addresses) and WMO. Each Class C network address can provide

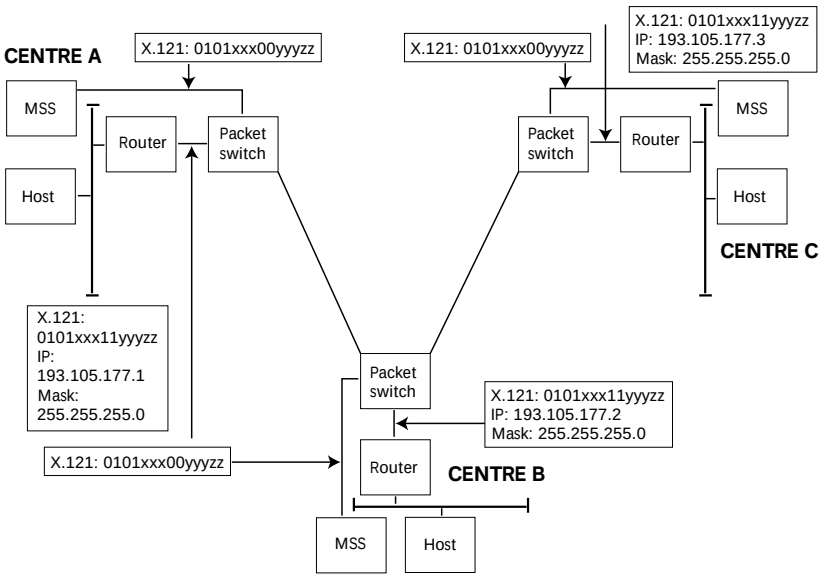


Figure 3.1 — IP implemented over X.25 network.

62 links (see box 'Allocation of Class C addresses for direct IP links', next page). The network addresses are:

MTN and Inter region links:	193.105.178.0
Links within RA I	193.105.179.0
Links within RA II	193.105.180.0
Links within RA III	193.105.181.0
Links within RA IV	193.105.182.0
Links within RA V	193.105.183.0
Links within RA VI	193.105.184.0

Further Class C addresses will be sought should the addresses available above be used up.

Figure 3.2 below illustrates how pair of Centres have agreed to implement a direct IP connection using the first available pair of 'host' numbers from the 193.105.178.0 network.

Addressing for X.25 over IP

Where two Centres have a common brand of router (e.g. Cisco), and the traffic is mostly IP with some X.25, it may be appropriate to carry the X.25 over the directly connected routers as shown for the link between Centre B and Centre C in Figure 3.3. The X.25 packets are carried within IP packets over the serial link between the routers, which may be a proprietary HDLC protocol, or a standard protocol such as PPP. This functionality requires that routers in each Centre contain X.25 packet switching software and that the X.25 route details are included in the router configuration. Examples of typical configurations are given in Appendix 1.

Implementation details

In order to implement IP services, Centres need to know certain details of IP and X.25 addressing at other Centres on the GTS. The following diagrams and associated tables explain in detail, the information required at various Centres:

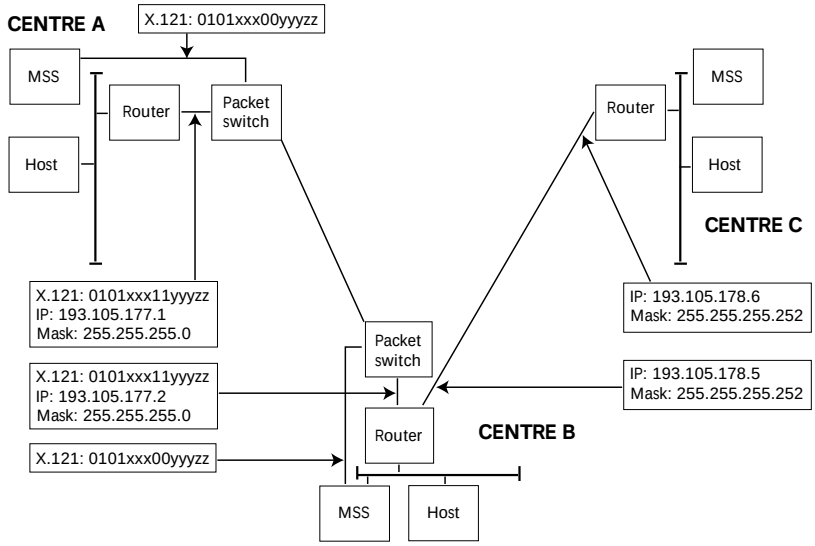


Figure 3.2 — Direct IP link between Centres B and C.

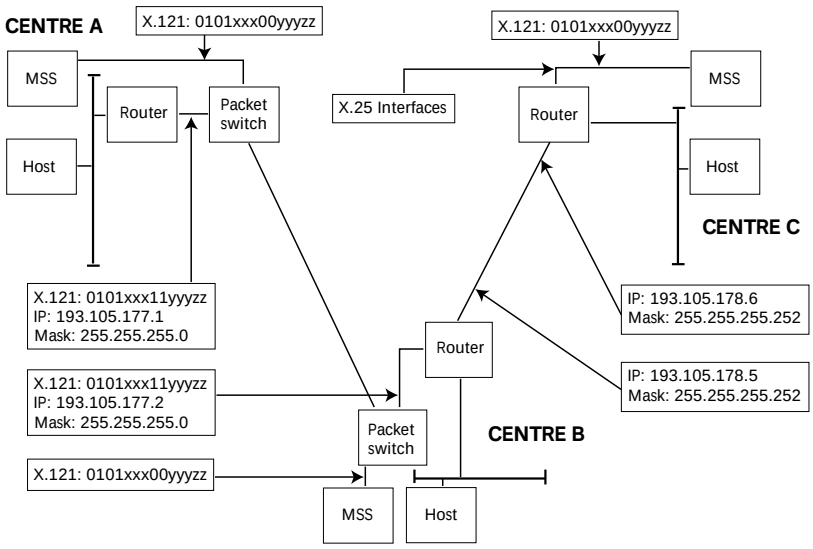


Figure 3.3 — Combination of IP over X.25 and X.25 over IP.

Allocation of Class C addresses for direct IP links

Routers have to be connected by links having unique subnet numbers. To achieve this, a Class C address is used (for example 193.105.178.0) with a mask of 255.255.255.252. This provides 62 subnets each with two hosts. These two host numbers are allocated to the ends of the link connecting the routers between the two Centres. The lowest useable network number is 193.105.178.4, with host addresses of 193.105.178.5 and 6. The next network number is 193.105.178.8, with host addresses of 193.105.178.9 and 10, followed by
193.105.178.12, with host addresses of 193.105.178.13 and 14, followed by
193.105.178.16, with host addresses of 193.105.178.17 and 18, followed by
193.105.178.20, with host addresses of 193.105.178.21 and 22, and so on, up to
193.105.178.248, with host addresses of 193.105.178.249 and 250.

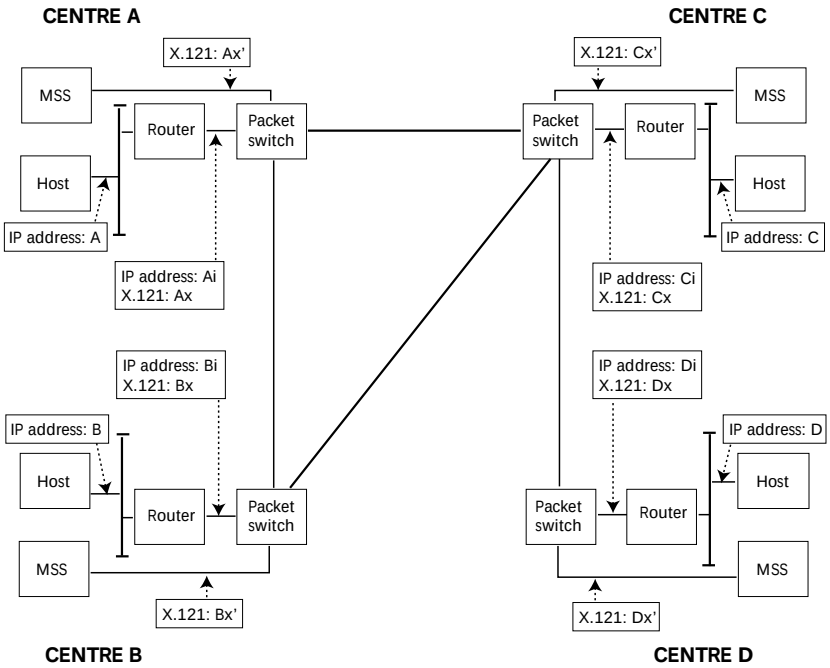


Figure 3.4 — IP over X.25 network.

Table 3.4*a*
IP and X.121 addresses to be known at CENTRE A

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE B (Host to host)	IP address : B	IP address : Bi X.121 : Bx	CENTRE A – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ci X.121 : Cx	CENTRE A – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Di X.121 : Dx	CENTRE A – CENTRE C – CENTRE D (Host [A] – Router [A] – Packet Switch [A] – Packet Switch [C] – Packet Switch [D] – Router [D] – Host [D]) [x] : CENTRE x
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE A – CENTRE B
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE A – CENTRE C
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE A – CENTRE C – CENTRE D (MSS [A] – Packet Switch [A] – Packet Switch [C] – Packet Switch [D] – MSS [D])

Table 3.4*b*
IP and X.121 addresses to be known at CENTRE B

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Ci X.121 : Cx	CENTRE B – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Di X.121 : Dx	CENTRE B – CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE B – CENTRE C
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE B – CENTRE C – CENTRE D

Table 3.4*c*
IP and X.121 addresses to be known at CENTRE C

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bi X.121 : Bx	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Di X.121 : Dx	CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE C – CENTRE D

Table 3.4*d*
IP and X.121 addresses to be known at CENTRE D

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE D – CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bi X.121 : Bx	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ci X.121 : Cx	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE D – CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE D – CENTRE C

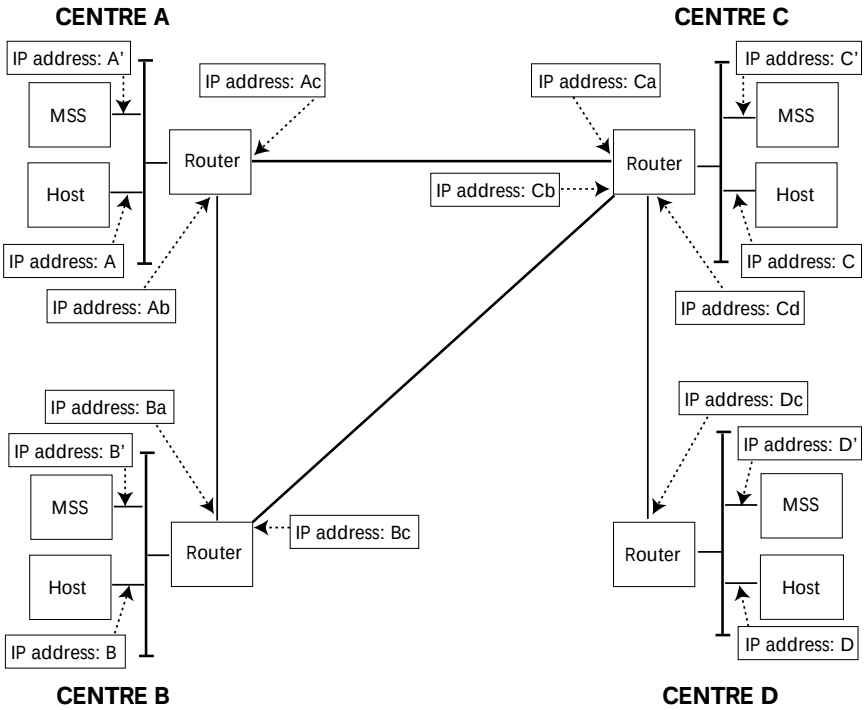


Figure 3.5 — Direct IP network.

Table 3.5*a*
IP address to be known at CENTRE A

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE B (Host to host)	IP address : B	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Ca	CENTRE A – CENTRE C – CENTRE D (Host [A] – Router [A] – Router [C] – Router [D] – Host [D]) [x] : CENTRE x
CENTRE B (MSS to MSS)	IP address : B'	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (MSS to MSS)	IP address : C'	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (MSS to MSS)	IP address : D'	IP address : Ca	CENTRE A – CENTRE C – CENTRE D

Table 3.5*b*
IP address to be known at CENTRE B

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Cb	CENTRE B – CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A'	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	IP address : C'	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (MSS to MSS)	IP address : D'	IP address : Cb	CENTRE B – CENTRE C – CENTRE D

Table 3.5*c*
IP address to be known at CENTRE C

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Dc	CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A’	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B’	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	IP address : D’	IP address : Dc	CENTRE C – CENTRE D

Table 3.5*d*
IP address to be known at CENTRE D

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Cd	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	IP address : A’	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B’	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	IP address : C’	IP address : Cd	CENTRE D – CENTRE C

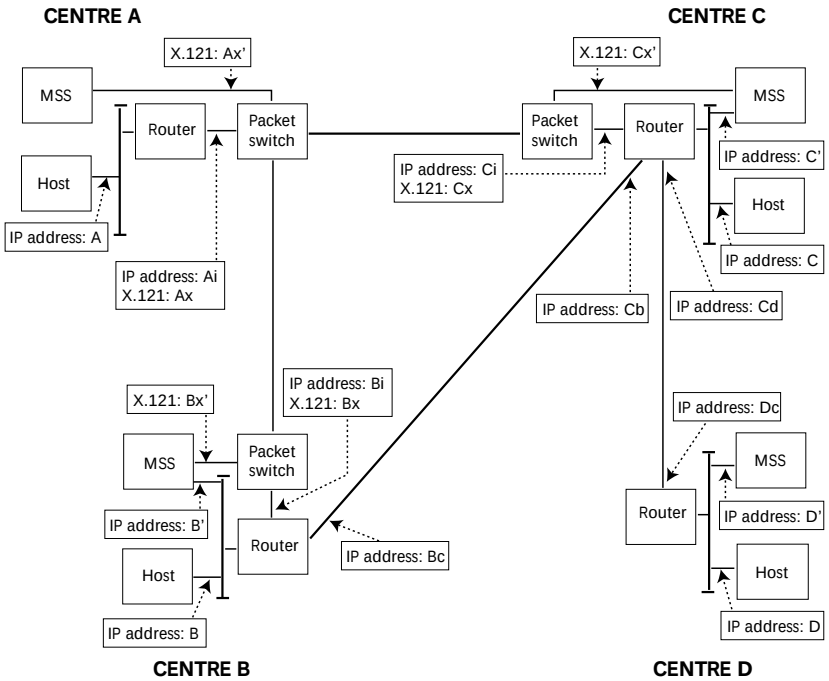


Figure 3.6 — Coexistence of direct IP with IP over X.25.

Table 3.6*a*
IP and X.121 addresses to be known at CENTRE A

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE B (Host to host)	IP address : B	IP address : Bi X.121 : Bx	CENTRE A – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ci X.121 : Cx	CENTRE A – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Ci X.121 : Cx	CENTRE A – CENTRE C – CENTRE D
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE A – CENTRE B
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE A – CENTRE C
CENTRE D (MSS to MSS)	Possible only by store and forward via MSS at Centre C (X.25 traffic)		

Table 3.6*b*
IP and X.121 addresses to be known at CENTRE B

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Cb	CENTRE B – CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	IP address : C'	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (MSS to MSS)	IP address : D'	IP address : Cb	CENTRE B – CENTRE C – CENTRE D

Table 3.6*c*
IP and X.121 addresses to be known at CENTRE C

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Dc	CENTRE C – CENTRE D
CENTRE B (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE C – CENTRE A
CENTRE C (MSS to MSS)	IP address : B'	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	IP address : D'	IP address : Bc	CENTRE C – CENTRE D

Table 3.6*d*

IP and X.121 addresses to be known at CENTRE D

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Cd	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	Possible only by store and forward via MSS at Centre C (X.25 traffic)		
CENTRE B (MSS to MSS)	IP address : B’	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	IP address : C’	IP address : Cd	CENTRE D – CENTRE C

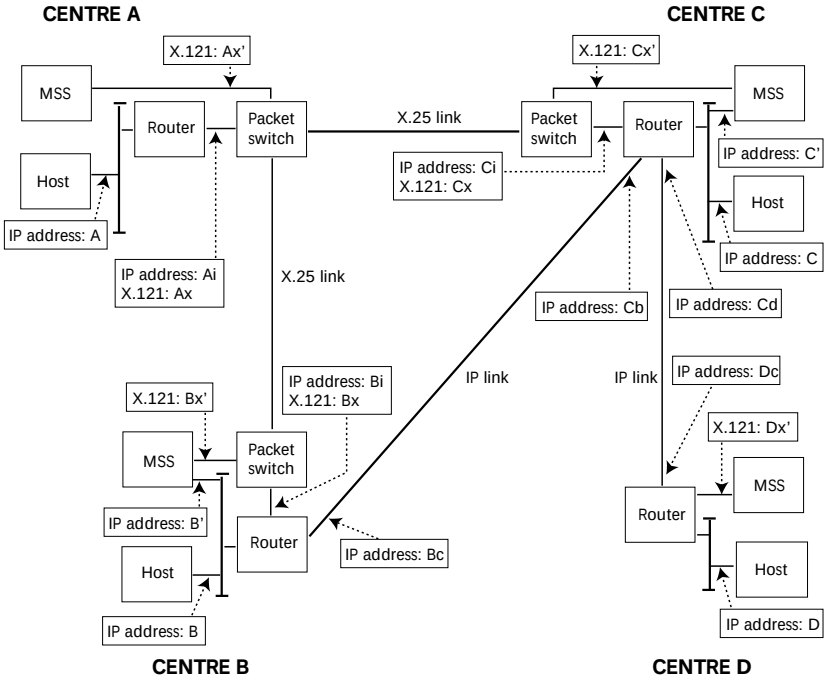


Figure 3.7 — Coexistence of direct I, IP over X.25 and X.25 over IP.

Table 3.7*a*

IP and X.121 addresses to be known at CENTRE A

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE B (Host to host)	IP address : B	IP address : Bi X.121 : Bx	CENTRE A – CENTRE B (Host [A] – Router [A] – "IP over X.25" – Packet Switch [A] – "IP over X.25" – Packet Switch [B] – "IP over X.25" – Router [B] – Host [B])
CENTRE C (Host to host)	IP address : C	IP address : Ci X.121 : Cx	CENTRE A – CENTRE C (Host [A] – Router [A] – "IP over X.25" – Packet Switch [A] – "IP over X.25" – Packet Switch [C] – "IP over X.25" – Router [C] – Host [C])
CENTRE D (Host to host)	IP address : D	IP address : Ci X.121 : Cx	CENTRE A – CENTRE C – CENTRE D (Host [A] – Router [A] – "IP over X.25" – Packet Switch [A] – "IP over X.25" – Packet Switch [C] – "IP over X.25 – Router [C] – "Direct IP" – Router [D] – Host [D])
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE A – CENTRE B (MSS [A] – Packet Switch [A] – Packet Switch [B] – MSS [B]
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE A – CENTRE C (MSS [A] – Packet Switch [A] – Packet Switch [C] – MSS [C]
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE A – CENTRE C – CENTRE D (MSS [A] – Packet Switch [A] – Packet Switch [C] – Router [C] – "X.25 over IP" – Router [D] – MSS [B])

Table 3.7*b*

IP and X.121 addresses to be known at CENTRE B

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Cb	CENTRE B – CENTRE C (Host [B] – Router [B] – "Direct IP" – Router [C] – Host [C])
CENTRE D (Host to host)	IP address : D	IP address : Cb	CENTRE B – CENTRE C – CENTRE D (Host [B] – Router [B] – "Direct IP" – Router [C] – "Direct IP" – Router [D] – Host [D])
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	IP address : C'	IP address : Cb	CENTRE B – CENTRE C (MSS [B] – Router [B] – "Direct IP" – Router [C] – MSS [C])
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE B – CENTRE C – CENTRE D (MSS [B] – Packet Switch [B] – Router [B] – "X.25 over IP" – Router [C] – "X.25 over IP" – Router [D] – MSS [D])

Table 3.7*c*
IP and X.121 addresses to be known at CENTRE C

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ai X.121 : Ax	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Dc	CENTRE C – CENTRE D (Host [C] – Router [C] – "Direct IP" – Router [D] – Host [D])
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B'	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	X.121 : Dx' (X.25 traffic)		CENTRE C – CENTRE D (MSS [C] – Packet Switch [C] – Router [C] – "X.25 over IP" – Router [D] – MSS [D])

Table 3.7*d*
IP and X.121 addresses to be known at CENTRE D

Destination	*Addresses to be known*		*Suitable route*
	For communication between ends	*For communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Cd	CENTRE D – CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Cd	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	X.121 : Ax' (X.25 traffic)		CENTRE D – CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	X.121 : Bx' (X.25 traffic)		CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	X.121 : Cx' (X.25 traffic)		CENTRE D – CENTRE C

Address management and allocation

X.25 addresses
The framework described above allows Centres full autonomy in allocating X.25 numbers. The WMO Secretariat will maintain a current list of X.25 addresses which Centres have allocated for use on the GTS. Centres are requested to notify the Chief of Telecommunications and Monitoring Unit, WWW Department, WMO Secretariat by E-mail or fax of X.25 addresses allocated.

IP addresses
IP addresses for use with IP over X.25 or for pure IP links will be coordinated and issued by the WMO Secretariat as required. Centres should direct requests for IP numbers to the Chief of Telecommunications and Monitoring Unit, WWW Department, WMO Secretariat by E-mail or fax.

GTS nominated host/network addresses
Host and subnet IP addresses for use with GTS nominated Centres should be notified to WMO as described above.

Publication of addresses
WMO will publish updated address lists in the monthly WWW *Operational Newsletter* and will also make these lists available in ASCII text form for access by FTP on the WMO web server and in World Wide Web format at http://www.wmo.ch.

4. Adapting message switching systems to TCP/IP

Introduction
Although there are new requirements emerging, for the time being GTS usage is dominated by the traditional message switching application, which has been developed to use X.25 packet switching. We now need to consider how best to migrate the message switching task to use TCP/IP to satisfy the new requirements by providing "Internet like" facilities on the GTS, and to stay aligned with IT industry trends. Additionally, migration of MSS to use TCP/IP means that X.25 infrastructure can be removed, greatly simplifying the technology of the GTS by moving to a pure IP network rather than a mixture of IP and X.25.

There are two possible technical approaches to this problem, one using TCP sockets and the other FTP.

In the long term, the FTP approach is thought be the most strategically attractive but may require more work to implement in operational MSS. It may suit some Centres to adopt an approach based on TCP sockets as the first step towards a TCP/IP-based GTS.

The transition of the MSSs to TCP/IP does not imply any change in the basic store and forward architecture of the GTS. It is envisaged that the store and forward architecture, with automatic on forwarding based on routing tables, will remain. However, the adoption of FTP means there is an additional option for data exchange to be achieved through bilateral arrangements, by the use of FTP retrieve initiated by the receiving Centre.

TCP sockets based on MSS

TCP socket is an approach which is highly suitable for a programmatic implementation to provide regular exchange of messages. As such it should simply be regarded as an alternative protocol to X.25. A Centre will be required to produce MSS application programs capable of transmitting and receiving via a TCP socket. Centres with current applications capable of driving an X.25 virtual circuit should be able to produce very quickly and simply a sockets version by changing a few system calls (see Appendix 2 for sample programs). The programming work involved is minimal and more importantly all other areas of the MSS such as queuing, routing, data management, operator interfaces, etc. remain unchanged because the communication exchange is still based on the traditional message.

The protocol defined here, is based on the assumption that the physical circuit over which the data is to be transmitted has low error rate and is subject to interruptions rarely. On such circuits, the TCP protocol can be expected to deliver error-free data. However, some GTS circuits may not be of sufficient quality for the standard TCP socket to function reliably. The development of special protocols for use on low quality circuits may be studied further.

One useful feature of the X.25-based communication that is not available using TCP sockets, is the ability to detect start and end of message by reference to the M bit in the X.25 packet header. No such bit or any equivalent feature exists in TCP. Therefore, to enable receiving centres to detect end of message, each message is preceded with an eight-character string giving the message length, plus two characters indicating message type (binary, alphanumeric or fax). Thereafter the message is structured within an SOH/ETX envelope as for exchange via X.25. The complete structure is illustrated in Figure 4.1. Note that the message length does not include itself or the type indicator. It should always be eight characters long and include leading zeroes as required. The message type indicator should be encoded using ASCII characters BI for binary, AN for alphanumeric, and FX for facsimile. All new connections established must begin with a message length and type structure.

The rules for use of TCP/IP socket exchange can be summarized as:

1. All new connections must start from a new message.
2. Once established a connection may be left up indefinitely.
3. Each message is preceded by a message length field of eight ASCII characters and a message type field of two ASCII characters.
4. Message length is counted from SOH to ETX inclusive and must contain leading zeroes as necessary.
5. Message type must be encoded as BI for binary, AN for alphanumeric or FX for facsimile.
6. Receiving centres will check synchronization as follows:
   (*a*) Check that the first eight characters are ASCII numeric;
   (*b*) Check that the ninth and tenth characters are BI, AN or FX;
   (*c*) Check that the eleventh character is SOH;
   (*d*) Check that the last character is ETX.
7. If synchronization is lost, the receiver shall break the connection.
8. Messages may be sent and received on single or separate connections (subject to bilateral agreement).
9. Binary data may be sent on a separate connection to character (subject to bilateral agreement).
10. TCP/IP service/port numbers for these connections will be decided by bilateral agreement.

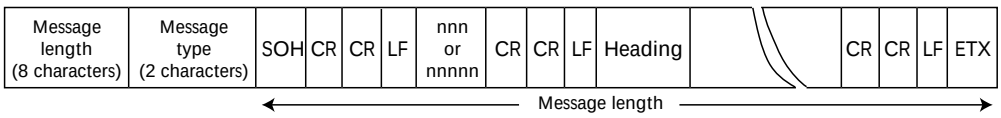
FTP procedures

Introduction

File Transfer Protocol (FTP) is a convenient and reliable method for exchanging files, especially large files. The protocol is defined in RFC 959.

The main issues to be considered are:

1. Procedures for accumulating messages into files so as to minimize FTP overheads with short messages (applies only to existing message types);
2. File naming conventions for existing message types (existing AHL);
3. File naming conventions for new message types (no existing AHL);



Message length: Length from SOH to ETX (e.g. 00001826 = 1826 bytes)
Message type AN: Alphanumeric, BI: Binary, FX: facsimile

Figure 4.1 — Message structure for socket exchange applications.

4. File renaming;
5. Use of directories;
6. Account names and passwords;
7. FTP sessions;
8. Local FTP requirements;
9. File compression.

Accumulating messages into files

One of the problems with using FTP to send traditional GTS messages is the overhead if each message is sent in a separate file. To overcome this problem, multiple messages in the standard GTS message envelope should be placed in the same file according to the rules set out below. This method of accumulating multiple messages applies only to messages for which AHLs have been assigned.

Centres have the option of including or deleting the starting line and end of message strings and indicating which option they are using via the format identifier (refer points 2 and 4 below).

1. Each message should be preceded by an 8 octet message length field (8 ASCII characters). The length includes the starting line (if present), AHL, text and end of message (if present).
2. Each message should start with either:
   (*a*) The currently defined starting line and AHL as shown in Figure 4.2, option 1; or
   (*b*) The AHL as shown in Figure 4.2, option 2.
3. Messages should be accumulated in files thus:
   (*a*) Length indicator, message 1 (8 characters);
   (*b*) Format identifier (2 characters);
   (*c*) Message 1;
   (*d*) Length indicator, message 2 (8 characters);
   (*e*) Format identifier (2 characters);
   (*f*) Message 2;
   (*g*) And so on, until the last message; and then
   (*h*) A 'dummy' message of zero length shall be inserted after the last real message, to assist with end of file detection in certain MSS systems.
4. Format identifier (2 ASCII characters) has the following values:
   (*a*) 00 if starting line and end of message strings present;
   (*b*) 01 if starting line and end of message strings absent.
5. The sending centre should combine messages in the file for no more the 60 seconds to minimize transmission delays.
6. The sending centre should limit the number of messages in a file to a maximum of 100.
7. The format applies regardless of the number of messages, i.e. it applies even if there is only one message in the file.

File naming conventions for existing message types (existing AHL)

The file naming convention is:

CCCCNNNNNNNN.ext

where:

CCCC is the international four-letter location identifier of the sending Centre, as defined in WMO-No. 9, Volume C;

NNNNNNNN is a sequential number from 0 to 99999999 generated by the sending Centre;

ext is:

'ua' for urgent alphanumeric information
'ub' for urgent binary information
'a' for normal alphanumeric information
'b' for normal binary information
'f' for facsimile information

NOTE: Where, through bilateral agreement, Centres allow alphanumeric and binary data in the one file, the b or ub extent shall be used.

File naming conventions for new message types (no existing AHL)

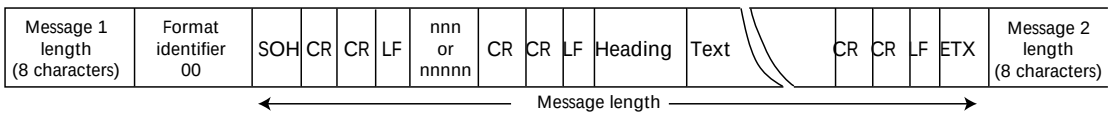
The procedure is based on transmission of file pairs, one file being the information file and the other being the associated metadata file. The concept of file pairs allows the communications function to be implemented independently of data management requirements for structure of metadata, yet provides for the carriage of whatever metadata is required. It is not compulsory to always have a .met file, such as when the information file itself is self-specifying.

The name of the information file shall be:

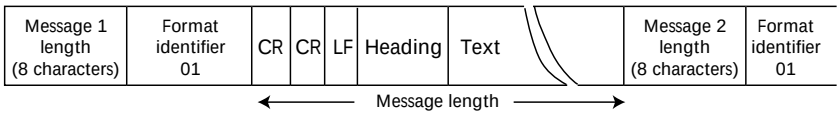
CCCCNNNNNNNN.ext

where:

CCCC is the international four-letter location identifier of the sending Centre, as defined in WMO-No. 9, Volume C;



Option 1. Starting line and end message present.
Message length: Length from SOH to ETX (e.g. 00001826 = 1826 bytes)



Option 2. Starting line and end message absent.
Message length: length from first CR to end of text (e.g. 00001826 = 1826 bytes)

Figure 4.2 — Structure of a typical message in a file.

NNNNNNNN is a sequential number from 0 to 99999999 generated by the sending Centre;
ext indicates the file type, e.g.:

.tif for TIFF file
.gif for GIF file
.ps for Postscript file
.mpg for MPEG file
.jpg for JPEG file
.txt for text file
.htm for HTML file
.bin for a file containing data encoded in a WMO binary code form such as GRIB or BUFR
.doc for a MS Word file
.wpd for a WordPerfect file

The name of the corresponding metadata file shall be:
CCCCNNNNNNNN.met
where CCCCNNNNNNNN is the same as the corresponding information file.

The structure of the '.met' file is not defined in this attachment. It will be as specified by CBS.

File renaming

The method used by receiving Centres to detect the presence of a new file may depend on the type of machine used. However most centres will do this by scanning a directory for new files.

To avoid problems with the receiving centre processing a file before it has completely arrived, all sending centres must be able to rename remotely the files they send.

The file shall be sent with the extent '.tmp' and then renamed to use the appropriate extent defined above when the transfer is completed.

e.g.:

(*a*) Put xxxxx RJTD00220401.tmp (xxxxx = local file name)
rename RJTD00220401.tmp RJTD00220401.a

(*b*) Put xxxxx AMMC09871234.tmp
rename AMMC 09871234.tmp AMMC09871234.gif

Use of directories

Some receiving Centres may wish the files to be placed in specific sub-directories. This should be limited to require only that all files of the same type be delivered to the same directory.

Account names and passwords

By using FTP, the sender "logs in" to a remote machine using a specific account name and password. The receiving centre defines the account name and the password. There are potential security implications for centres so care needs to be taken.

The following general rules should however apply.

1. The receiving Centre defines the user account and password for the sending centre.
2. Anonymous FTP may be used or a specific account may be created. (If anonymous FTP is used, each sending Centre must have its own sub-directory on the FTP server).

FTP sessions

To limit the load on both the sending and receiving systems, no more than one FTP session per file type should exist at the same time. If for example, Centre A wishes to send two files to Centre B of the same type (say .ua), the second file must not be sent until the first is finished. Centres should limit the number of concurrent sessions with a particular Centre to five maximum.

Local FTP requirements

All sending Centres will need to allow for additional "static" FTP commands to be included in the FTP commands that they issue. For example some MVS Centres may require the inclusion of "SITE" commands to define record and block lengths. Centres should support FTP commands as specified in RFC 959 unless some are excluded by bilateral agreement. There may also need to be bilaterally agreed procedures and commands.

It is the responsibility of receiving Centres to delete files after they have been processed.

Use of file compression

If large files are to be sent then it is often desirable to compress them first.

Centres should only use compression by bilateral agreement.

If possible, centres should support the following two compression methods. Other methods may be used by bilateral agreement.

1. UNIX "compress"
2. Gzip
   This means that a received file could be of the form:
   "xxxxxxxx.ext.Z" or "xxxxxxxx.ext.gz".

Backup with an IP-based GTS

A final consideration is that of MSS backup. The new GTS will use IP addresses, where an individual address is usually associated with only one system. Should a system fail and an alternative be used there are implementation issues to be considered by transmitting Centres. Ideally a transmitting Centre should be unaffected by a receiving Centre's backup arrangements. This is a good principle, which all Centres should seek to adhere to. However it may not always be possible to achieve complete IP transparency. If this cannot be done, sending Centres must be prepared to try an alternate IP address. Once using such an alternate address it must periodically try the primary address. It is suggested that such periodicity be established by bilateral agreement between centres because it will be heavily influenced by each centres backup strategy.

5. Trouble shooting and problem resolution

IP layer tools

In a large IP network, every router involved in the path between two hosts must know what is the next hop to be used to reach the destination address. As every

router and/or link might be a point of failure, it is very important to determine rapidly where the problem is and then, how to solve it.

There are two tools, ping and traceroute, which could be used to determine where the potential problems are.

PING

The first basic tool called ping will check if the destination IP address can be reached. This tool is standard in almost every operating system with TCP/IP. On a Unix host the output looks like:

```
zinder# ping -s cadillac
PING cadillac : 56 data bytes
64 bytes from cadillac (193.168.1.17): icmp_seq=0.
time=3. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=1.
time=2. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=2.
time=3. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=3.
time=3. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=4.
time=5. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=5.
time=3. ms
64 bytes from cadillac (193.168.1.17): icmp_seq=6.
time=3. ms
----cadillac PING statistics----
7 packets transmitted, 7 packets received, 0 per
cent packet loss
round-trip (ms) min/avg/max = 2/3/5
```

This gives rather valuable information. If packets can be sent to, and received from a particular address, the level 3 (IP protocol layer) is working fine.

If the output of ping shows that 100 per cent packets are lost, it means either that there is a failure on some part of the network or that the receiving host is down. Usually, to distinguish between these two possibilities, the easiest method is to ping a host known to be on the same network. If it fails too, the network is probably out of order somewhere.

With ping you can also check if the network performance are reasonable. The time is the delay between sending and receiving back the packet. It is not really possible to give an average value of that delay, but it is more important to notice variation in that number.

Finally, it might happen that packets are lost. In this case, there are missing numbers in the icmp_seq number. Either packet loss or variation in delays will badly degrade the performance.

TRACEROUTE

This tool is used to show which routers are transited on the network between A and B. It is not available on all systems, but is rather easy to compile. It is a free tool available on the Internet[2]. Traceroute output looks like:

```
cadillac 22: traceroute ftp.inria.fr
traceroute to ftp.inria.fr (192.93.2.54), 30 hops max,
40 byte packets
 1  antonio.meteo.fr (137.129.1.5) 3 ms 2 ms
    2 ms
 2  clara.meteo.fr (137.129.14.249) 1 ms 2 ms 2 ms
 3  andrea.meteo.fr (193.105.190.253) 4 ms 3 ms
    2 ms
 4  octares1.octares.ft.net (193.48.63.5) 30 ms 35 ms
    10 ms
 5  192.70.80.97 (192.70.80.97) 9 ms 15 ms 27 ms
 6  stamand1.renater.ft.net (195.220.180.21) 40 ms
    96 ms 29 ms
 7  stamand3.renater.ft.net (195.220.180.41) 56 ms
    100 ms 108 ms
 8  stlambert.rerif.ft.net (195.220.180.10) 63 ms
    56 ms 34 ms
 9  193.55.250.34 (193.55.250.34) 46 ms 28 ms
    26 ms
10  rocq-gwr.inria.fr (192.93.122.2) 21 ms 147 ms
    85 ms
11  ftp.inria.fr (192.93.2.54) 86 ms 58 ms 128 ms
```

When a router does not know where to sent the packet, the result may be like the following:

```
cadillac 22: traceroute 193.105.178.5
traceroute to 193.105.178.5 (193.105.178.5), 30 hops
max, 40 byte packets
 1  antonio.meteo.fr (137.129.1.5) 2 ms 1 ms 1 ms
 2  clara.meteo.fr (137.129.14.249) 1 ms 4 ms 1 ms
 3  andrea.meteo.fr (193.105.190.253) 4 ms 11 ms
    4 ms
 4  octares1.octares.ft.net (193.48.63.5) 42 ms 39 ms
    42 ms
 5  192.70.80.97 (192.70.80.97) 8 ms 7 ms 7 ms
 6  stamand1.renater.ft.net (195.220.180.5) 48 ms 86
    ms 113 ms
 7  rbs1.renater.ft.net (195.220.180.50) 63 ms 107 ms
    154 ms
 8  Paris-EBS2.Ebone.net (192.121.156.105) 146 ms
    167 ms 140 ms
 9  stockholm-ebs-s5-2.ebone.net (192.121.154.21)
    100 ms 80 ms 92 ms
10  Amsterdam-ebs.Ebone.NET (192.121.155.13) 249
    ms 227 ms 205 ms
11  amsterdam1.NL.EU.net (193.0.15.131) 257 ms 249
    ms 316 ms
12  * Amsterdam5.NL.EU.net (134.222.228.81) 300 ms
    297 ms
13  Amsterdam6.NL.EU.net (134.222.186.6) 359 ms
    218 ms 304 ms
14  Paris1.FR.EU.net (134.222.228.50) 308 ms 311 ms
    388 ms
15  * Etoile0.FR.EU.net (134.222.30.2) 177 ms *
16  Etoile0.FR.EU.net (134.222.30.2) * * *
```

In the second case, cadillac would not be able to reach 193.105.178.5 because the router Etoile0.fr.eu.net failed to send the packet. With traceroute, it is not possible to know if it is a router failure or a link failure.

2 ftp ://ftp.switch.ch/software/sources/network or ftp://ftp.rediris.es/software/sources/network

Traffic control tools

IP connectivity is the first step, but to achieve good performance, this is not enough. It is sometime necessary to look at other tools to understand what is happening. There are lot of solutions. It is possible to use protocol analysers and SNMP-based software tools.

For example, Sun Microsystems bundles with Solaris a tool called snoop who can replace in most cases a local area network analyser. Others tools such as TCPDUMP and NNSTAT are available for free on the Internet and can be installed on various systems.[2]

These tools require a rather good knowledge of IP protocol. But, for example, TCPDUMP[2] might be used to diagnose applications level problems.

```
pontiac#/usr/local/bin/tcpdump -i nf0 host cadillac
and zinder and proto icmp
15:28:06.68 cadillac.meteo.fr>zinder.meteo.fr: icmp:
echo request
15:28:06.68 zinder.meteo.fr>cadillac.meteo.fr: icmp:
echo reply
15:28:19.45 cadillac.meteo.fr>zinder.meteo.fr: icmp:
echo request
15:28:19.45 zinder.meteo.fr>cadillac.meteo.fr: icmp:
echo reply
15:28:29.44 cadillac.meteo.fr>zinder.meteo.fr: icmp:
echo request
15:28:29.45 zinder.meteo.fr>cadillac.meteo.fr: icmp:
echo reply
```

This example shows on host pontiac, how to capture all ICMP exchanges between zinder and cadillac. There are plenty of options in TCPDUMP. This one is one of the most basic available.

NNSTAT[2] may be used to obtain traffic matrix, statistics on network usage. Like TCPDUMP, it is a little bit hard to use but can give very useful information. It is also a free tool. Unfortunately, it runs also on rather old operating systems such like SunOS 4.x or Ultrix

```
OBJECT: autres.in Class=matrix-sym-bytes [Created:
15:24:12 02-14-94]
    ReadTime: 15:35:00 02-14-94, ClearTime: 15:30:00
    02-14-94 (@-300sec)
    Total Count= 3734 (+0 orphans)
    Total Bytes= 2061168B #bins = 1
[136.156.56.1:137.129.1.2]= 3734&2061168B (100.0%)
@-0sec
```

```
OBJECT: autres.in Class=matrix-sym-bytes [Created:
15:24:12 02-14-94]
    ReadTime: 15:40:00 02-14-94, ClearTime: 15:35:00
    02-14-94 (@-300sec)
    Total Count= 4004 (+0 orphans)
    Total Bytes= 2173325B #bins = 2
[136.156.56.1:137.129.1.2]= 3931&2168888B (98.2%)
@-0sec
[136.156.22.68:137.129.1.4]= 73&4437B (1.8%) @-
140sec

OBJECT: autres.in Class=matrix-sym-bytes [Created:
15:24:12 02-14-94]
    ReadTime: 15:45:00 02-14-94, ClearTime: 15:40:00
    02-14-94 (@-300sec)
    Total Count= 2607 (+0 orphans)
    Total Bytes= 1438552B  #bins = 1
[136.156.56.1:137.129.1.2]= 2607&1438552B (100.0%)
@-111sec
```

In the output above, we saw for five-minute periods, which hosts exchange traffic. These tools can select for example to capture only FTP traffic between two subnetworks, and give matrix traffic according to this selection method.

Simple network management (SNMP)

Simple network management protocol was developed in the late 1980s in order to offer to network manager a standard tool for controlling networks. In most case SNMP could be used to replace the more crude tools described above. Unfortunately, good SNMP software is not cheap. SNMP is a client-server protocol. In order to be able to gather information with SNMP, the equipment connected on the network must have Management Information Base (MIB). These bases are catalogues of integer, counters, strings, etc.... The manager asks the agents to send it some values. These values might be for example, IP routing table.

Information given above with TCPDUMP and NNSTAT might be obtained with SNMP but to do so, probes running the remote monitoring MIB must be connected on the network.

On a bilateral basis, it might be useful for Centres to allow SNMP access to their router from the other NMC. However, regular polling of other Centres' routers should be avoided to avoid overloading of circuits.

Title: : monica.meteo.fr
Name or IP address: monica.meteo.fr

ipRouteDest	*ipRouteMask*	*ipRouteNextHop*	*ipRouteProto*	*ipRouteMetric1*
0.0.0.0	0.0.0.0	137.129.1.5	local	0
136.156.0.0	255.255.0.0	137.129.1.5	ciscoIgrp	8786
137.129.1.0	255.255.255.0	137.129.1.6	local	0
137.129.2.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110
137.129.3.0	255.255.255.0	137.129.3.254	local	0
137.129.4.0	255.255.255.0	137.129.4.254	local	0
137.129.5.0	255.255.255.0	137.129.5.254	local	0
137.129.6.0	255.255.255.0	137.129.1.62	local	0
137.129.7.0	255.255.255.0	137.129.7.254	local	0
137.129.8.0	255.255.255.0	137.129.8.254	local	0
137.129.9.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110

APPENDICES

1. CISCO ROUTER CONFIGURATIONS

This appendix is not intended to be a complete description of all available commands in a Cisco nor a full course on these equipment, but it may be useful to describe more precisely the configuration tasks in order to comply with the policy outlined in chapter 2 of this attachment.

The configuration described below respects what is available in release 11.1 of the Cisco software. Some features are not available in previous release, and some will be modified in the future.

We are going to describe different steps:

1. Establishing IP connection
   - IP over PPP;
   - IP over X25;
   - X25 over IP (in fact it is X25 over TCP, the XOT protocol).
2. Routing configuration
   - Leaf node with static routes (Centre A);
   - Leaf node with dynamic routing (Centre C);
   - Configuration in a non-leaf node (in our case two different GTS connections, Centre B).
3. Security configuration
   - Filtering traffic based on declared IP addresses;
   - Controlling routing exchanges between GTS and the Internet.

In our example, A is connected to B with IP over X25 link, B is connected to C with IP over PPP. There is also the option for the MSSs at B and C to communicate using X.25 over TCP/IP. A is a leaf node, B and C non-leaf nodes. B and C are also connected to the Internet. B and its Internet provider use static routes[3], C and its own RIP.[4]

The following will be used along this appendix:

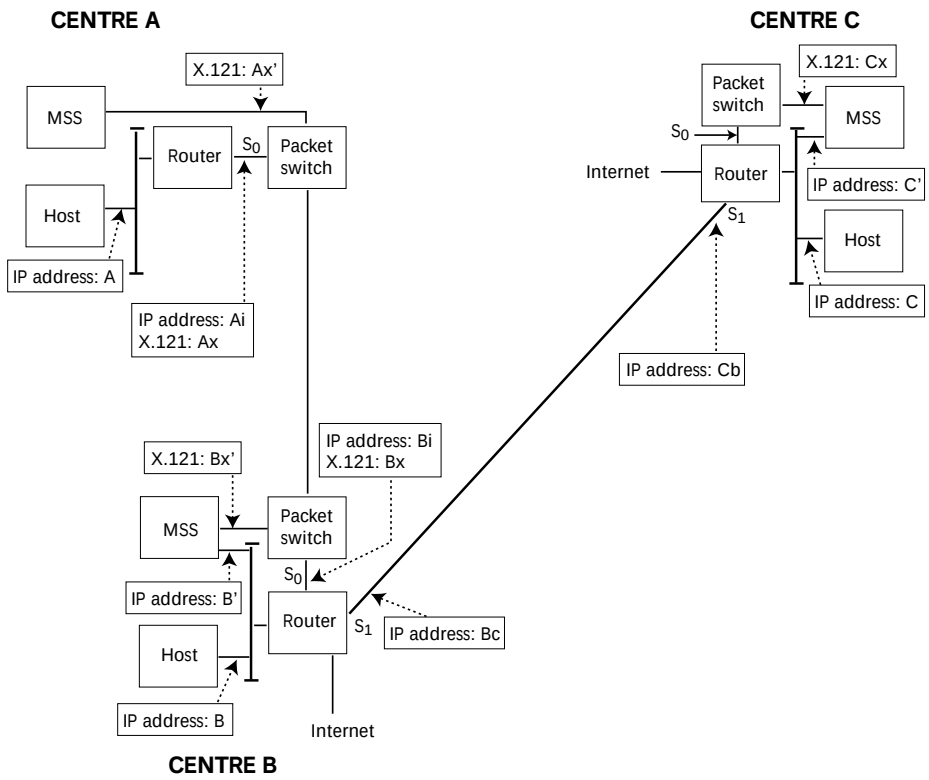
	X121 router address	*IP router address*	*IP hosts address for GTS*	*Autonomous system*
Centre A	0101666 1166666	193.105.177.1	194.168.1.16/ 255.255.255.248	N.A.
Centre B	0101777 1177777	193.105.177.2 193.105.178.5	137.129.9.0/ 255.255.255.0	65001
Centre C	0101888 1188888	193.105.178.6	195.1.1.0/ 255.255.255.0	65200

In Centres A and B, serial 0 interfaces are used to connect to the packet switches. In B and C, serial 1 interfaces are used for the PPP link.

Step 1: Establishing connections
Centre A
interface serial 0
encapsulation X25
! depending on local set-up (virtual channels, windows...) extra configuration might be necessary
x25 address 01016661166666
ip address 193.105.177.1 255.255.255.0
x25 map ip 193.105.177.2 01017771177777

3 B cannot use EGP and BGP on the same router; one router cannot belong to more than one AS.

4 RIP is NOT a good choice for such type of configuration. But as RIP is the most basic protocol, it is used in this case too.



```
Centre B
interface serial 0
encapsulation X25
x25 address 01017771177777
! depending on local set-up (virtual channels, windows... ) extra configuration might be necessary
ip address 193.105.177.2 255.255.255.0
x25 map ip 193.105.177.1 01016661166666
!
interface serial 1
encapsulation PPP
ip address 193.105.178.5 255.255.255.252
!
! X25 over TCP commands
x25 routing
x25 route 010188811* ip 193.105.178.6
x25 route 010177711* interface serial 0
!

Centre C
interface serial 0
encapsulation X25
x25 address 01018881188888
! depending on local set-up (virtual channels, windows... ) extra configuration might be necessary
interface serial 1
encapsulation PPP
ip address 193.105.178.6 255.255.255.252
!
! X25 over TCP commands
x25 routing
x25 route 010177711* ip 193.105.178.5
x25 route 010188811* interface serial 0
!
```

After this first step, IP configuration between routers is complete. The router in Centre A can then ping router in B. B can ping A and C but, A and C cannot communicate because there is no routing set up.

MSS at B and C can communicate with IP (once end-to-end routing is established) or with X25 over TCP. Experience has shown that all the X25 parameters on router in Centres B and C MUST be the same (packet size, window size) to avoid any strange behaviour.

```
Step 2: Routing
Centre A
! Simply define a default route with a metric 10 (the price) via B
ip route 0.0.0.0 255.255.255.255 193.105.177.2 10

Centre B
! First define static route with A
ip route 194.168.1.16 255.255.255.248 193.105.177.1 10
ip route 0.0.0.0 ip_provider_address 10
! BGP routing
router bgp 65001
network 137.129.9.0 mask 255.255.255.0
neighbour 193.105.178.6 remote-as 65200
! Route to A is static, force sending to C
redistribute static

Centre C
! BGP routing
router bgp 65200
network 195.1.1.0
neighbour 193.105.178.5 remote-as 65001
! 196.1.1.0 is network address for non-GTS hosts in C
router rip
network 195.1.1.0
```

A defined a default route. So, when A wants to communicate with C, the router knows where to send packets. C is going to receive routing information from B so A is also reachable from C. It is also important to note that if A tries to reach an Internet site, attempts will be made through B's Internet connection. It will fail because returning packets to A will not be sent to B. The link A to B link will thus carry some inappropriate data.

```
Step 3: Security
Centre A
! Declare which hosts can use GTS
access-list 1 permit 194.168.1.16 0.0.0.7
! Declare which hosts can come from GTS
access-list 2 permit 195.1.1.0 0.0.0.255
access-list 2 permit 137.129.9.0 0.0.0.255
interface serial 0
ip access-group 1 out
ip access-group 2 in

Centre B
! Declare which hosts can use GTS
access-list 1 permit 137.129.9.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 195.1.1.0 0.0.0.255
access-list 2 permit 194.168.1.16 0.0.0.7
ip as-path access-list 3 permit ^65???
interface serial 0
ip access-group 1 out
ip access-group 2 in
interface serial 1
ip access-group 1 out
ip access-group 2 in
! Restrict BGP updates
router bgp 65001
network 137.129.9.0 mask 255.255.255.0
neighbour 193.105.178.6 remote-as 65200
neighbour 193.105.178.6 filter-list 3 in
neighbour 193.105.178.6 filter-list 3 out
redistribute static

Centre C
! Declare which hosts can use GTS
access-list 1 permit 195.1.1.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 137.129.9.0 0.0.0.255
access-list 2 permit 194.168.1.16 0.0.0.7
```

```
! Only accept BGP updates with AS looking like 65xxx
ip as-path access-list 3 permit ^65???
interface serial 0
ip access-group 1 out
ip access-group 2 in
! Restrict BGP updates
router bgp 65200
network 195.1.1.0 mask 255.255.255.0
neighbour 193.105.178.5 remote-as 65001
neighbour 193.105.178.5 filter-list 3 in
neighbour 193.105.178.5 filter-list 3 out
```

In these configurations, there are two important features:

(*a*) BGP filtering

The access-list 3 both in B and C checks the autonomous system number sent by its neighbour. By filtering in and out in the BGP process this guarantees that all known routes must be issued from one of these ASs.

(*b*) IP filtering

The access-list 1 list allows IP addresses issued from within each Centre. This list should be quite stable. The access-list 2 checks the incoming IP addresses. As new Centres are added to the IP network, the corresponding addresses must be added to these access-lists.

It must also be noted that despite Internet connections in B and C no extra attention is required to control routing exchange. A static default route is not sent even if « redistribute static » is enabled. RIP and BGP ignore routing information known via the other protocol.

2. SAMPLE SOCKET SEND AND RECEIVE ROUTINES

```
/*************************************************************
* Sample TCP/IP socket program that SENDS a single
* message
*************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

/* TCP/IP DESTINATION and SERVICE ARE DEFINED BY THE RECEIVING CENTRE */
#define DESTINATION     "localhost"
#define SERVICE         39000
#define GTS_LENFIELD 8
#define MAX_MSGSIZE     15000

static void GetDestinationInfo();
static void SetupSocket();
static void SendData();
static void MakeConnection();
static struct sockaddr_in dest;
static int          pr_sock;

/*************************************************************
*                    MAINLINE
* 1. Ignore SIGPIPE signals. These are generated if a
*    connection is lost. By default they cause a program
*    to terminate.
* 2. Get information about the destination
*    (GetDestinationInfo):
*    - IP number (and name)
*    - Service/Port number
* 3. Create a TCP/IP Socket (SetupSocket)
* 4. Connect to the destination centre
*    (MakeConnection)
* 5. Send the message (SendData)
* 6. Close the socket (close)
*************************************************************/
main(int argc, char *argv[ ])
{

signal (SIGPIPE,SIG_IGN);

GetDestinationInfo();
SetupSocket();
MakeConnection();
SendData();
close(pr_sock);

}

/*************************************************************
*                GET DESTINATION INFO
*    Store the destination IP number and service
*    number in a socket structure (dest).
* 1. Convert the destination name to an IP number
*    (gethostbyname)
* 2. Store the IP number and service number in the
*    "dest" structure.

*************************************************************/
static void GetDestinationInfo()
{
struct hostent *hp;

hp = gethostbyname (DESTINATION);
if ( hp == NULL ) {
  printf("host error\n");
  exit(1);
  }


memset ((char *)&dest, 0, sizeof dest);
memcpy (&dest.sin_addr.s_addr, hp->h_addr, hp->h_length);
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;
}
```

```
/*************************************************************
*                          SETUP SOCKET
* Setup a TCP/IP Socket
* 1.  Create the socket
* 2.  Set the socket KEEPALIVE option.
*     This enables the automatic periodic transmission
*     of "check" messages to be sent on the connection.
*     If the destination does not respond then it is
*     considered broken and this process is notified
*     (by SIGPIPE or end-of-file)
* 3.  Set the socket REUSEADDR option. Enable quicker
*     restarting of terminated processes.
* 4.  Reduce the size of the Socket send buffer to reduce
*     the amount of data lost if the connection fails.
*************************************************************/
static void SetupSocket()
{
int       on = 1;
int       rc;
int       buffsize = MAX_MSGSIZE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
  printf("sock error\n");
  exit(1);
  }

 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,
(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
   }

  rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEAD-
DR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
   }

rc = setsockopt(pr_sock,SOL_SOCKET,SO_SNDBUF,
(char *)&buffsize,sizeof(buffsize));
 if (rc != 0) {
  printf("unable to set send buffer size\n");
   }

}


/*************************************************************
*                       MAKE CONNECTION
* Attempt to make a TCP/IP Socket connection to the
* destination on the agreed service/port number.
*************************************************************/
static void MakeConnection()
{
int       length;

length = sizeof (dest);
if ( connect (pr_sock,(struct sockaddr *)&dest,length)
== -1 ) {
  printf("connection error\n");
  exit(1);
  }

printf("connected\n");
}

/*************************************************************
*                          SEND DATA
* Send a message on the socket (5 times actually).
*
* NOTE: A real program would check the return code
* from the write and if the write failed it would close
* the socket, raise an operator alarm, and then try to
* re-send from the start of the message
*************************************************************/
static void SendData()
{
char      msg[MAX_MSGSIZE+1],   buffer[MAX_MSG-
SIZE+GTS_LENFIELD+3];
int       buflen, i, rc = 0;

strcpy(msg,"\001\r\r\n001\r\r\nTTAA01    AMMC
000000\r\r\n");
for (i=0;i<60;i++)
  strcat(msg,"THE QUICK BROWN FOX JUMPS OVER
THE LAZY DOG 0123456789\r\r\n");
strcat(msg,"\r\r\n\003");

sprintf(buffer,"%0*dAN%s",GTS_LENFIELD,strlen(msg),
msg);
buflen = strlen(buffer);

for (i=0; i<5; i++) {
  rc = write(pr_sock,buffer,buflen);
  printf("write. rc = %d\n",rc);
  }

}

/*************************************************************
*      TEST TCP/IP SOCKET RECEIVING PROGRAM
* Program is designed to give some ideas as to how to
* receive GTS style messages on a TCP/IP socket
*   connection.
*************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

#define SERVICE          39000
#define MAX_MSGSIZE      15000
```

```
#define MAX_BUFLEN          MAX_MSGSIZE + 100
#define SOH                 '\001'
#define ETX                 '\003'
#define GTS_LENFIELD                    8
#define GTS_SOCKET_HEADER               10

static void SetupService();
static void RecvData();
static void AcceptConnection();
static int ExtractMsg(char *buffer, int *buflen);
static int CheckMsgBoundaries (char *, int);
static int FindMessage (char *, int, int *);
static void ShiftBuffer (char *, int *, int);

static struct sockaddr_in dest;

static int          pr_sock, msgsock;
static char         buffer[MAX_BUFLEN+1];
static int          buflen = 0;

/*************************************************************
*                        MAIN
*   Listen for incoming IP calls and read any incoming
*   messages on the first call established.
*
* 1. Ignore SIGPIPE signals. These are generated if a
     connection is lost. By default they cause a program
     to terminate.
* 2. Set-up a listening socket for incoming msgs
     (SetupService)
* 3. Accept the first call received (AcceptConnection)
* 4. Read any messages on this connection (RecvData)
* 5. Close the call and close the listening socket.
*************************************************************/
main(int argc, char *argv[ ])
{

signal (SIGPIPE,SIG_IGN);

SetupService();
AcceptConnection();
RecvData();

close(msgsock);
close(pr_sock);
}

/*************************************************************
*                      SETUP SERVICE
* Listen for calls on a given Service/Port.
* 1. Create a socket
* 2. Set the socket KEEPALIVE option.
*    This enables the automatic periodic transmission
*    of "check" messages to be sent on the connection.
*    If the destination does not respond then it is
*    considered broken and this process is notified (by
*    SIGPIPE or end-of-file)
* 3. Set the socket REUSEADDR option. Enable quicker
*    restarting of terminated processes.
* 4. Bind the socket to the required Service/Port
* 5. Start listening for calls.
*************************************************************/
static void SetupService()
{
int       on = 1;
int       rc;

memset ((char *)&dest, 0, sizeof dest);
dest.sin_addr.s_addr = INADDR_ANY;
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
  printf("sock error\n");
  exit(1);
  }
 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,
(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
  exit(1);
  }
  rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEAD-
DR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
  exit(1);
  }

rc = bind(pr_sock,(struct sockaddr *)&dest,sizeof dest);
if ( rc < 0) {
  printf("bind error\n");
  exit(1);
  }

rc = listen(pr_sock,1);
if ( rc < 0) {
  printf("listen error\n");
  exit(1);
  }

printf("listening\n");
}

/*************************************************************
*                   ACCEPT CONNECTION
* Wait for an incoming call (accept).
* Return the socket of the call established.
*************************************************************/
static void AcceptConnection()
{
int       addrlen;

printf("waiting connection\n");

addrlen = sizeof(sockaddr_in);
msgsock = accept (pr_sock,&dest,&addrlen);
```

```
if ( msgsock < 0) {
  printf("accept error\n");
  exit(1);
  }
printf("connected\n");
}

/*********************************************************
*                        RECV DATA
* Read data from the message/call socket.
* Extract GTS messages from this data.
* Keep reading until the sender drops the call or there
* is an error.
*********************************************************/
static void RecvData()
{
int        numr = 1;
int        rc = 0;

while (numr > 0 && rc >= 0) {
   numr = read(msgsock,buffer+buflen, MAX_BUFLEN-
buflen);
  if (numr > 0) {
    buflen += numr;
    buffer[buflen] = '\0';
    printf("buffer = %s\n",buffer);
    rc = ExtractMsg(buffer,&buflen);
    }
  }
}

/*********************************************************
*                        EXTRAT MSG
* DESCRIPTION
* This function accepts a buffer of data on input,
* along with the amount of data in the buffer, and
* extracts GTS messages from this buffer.
*
* Messages that are in the buffer are identified as
* follows...
*
* The first 8 bytes of the message buffer HAVE to be a
* message length in character format.
* If the length exceeds the GTS defined maximum
* message size, or does not consist of numeric
* characters, then an error is returned (lost
* synchronisation).
*
* Immediately following the message length is a
* 2 character
* Message Type: "AN" = Alphanumeric, "BI" =
* binary, "FX" = Fax
*
* The GTS message begins with a SOH character, and is
* terminated with a ETX character, if this does not occur,
* then an error is returned (lost synchronization).
*
* If a GTS message is identified, then it is extracted
* and the message is shifted out of the buffer.
*
* As there may be more than 1 message in the
* buffer, this function will loop (extracting
* messages) until either and error or incomplete
* message is detected.
*
*
* RETURNS = 0 - Not a complete message in the
* buffer.
*                < 0 - Fatal error in the format of the
*                buffer.
*                > 0 - Success, the message(s) have been
*                extracted
*********************************************************/
static int ExtractMsg(char *buffer, int *buflen)
{
int       rc, msglen;
char      msg[MAX_MSGSIZE+1];

/* FIND THE FIRST MESSAGE IN THE BUFFER */
rc = FindMessage (buffer, *buflen, &msglen);

/* WHILE A VALID MESSAGE LENGTH IS FOUND IN
THE MESSAGE BUFFER... */
while (rc > 0) {

 /* ENSURE THAT THE FIRST CHARACTER AFTER THE
MESSAGE LENGTH IS A 'SOH' CHARACTER, AND THE
LAST CHARACTER AS INDICATED BY THE MESSAGE
LENGTH IS AN 'ETX' CHARACTER. */
 if ( (rc = CheckMsgBoundaries (buffer, msglen)) < 0 )
   continue;

 /* PRINT THE EXTRACTED MESSAGE */
 memcpy(msg,buffer+GTS_SOCKET_HEADER,msglen);
 msg[msglen] = '\0';
 printf("GTS MSG = \n%s\n",msg);

 /* SHIFT THE JUST INJECTED MESSAGE OUT OF THE
MESSAGE BUFFER, AND LOOP BACK TO LOOK FOR A
NEW MESSAGE. */

 ShiftBuffer (buffer, buflen, msglen);


 /* FIND THE FIRST MESSAGE IN THE SHIFTED BUFFER*/
 rc = FindMessage (buffer, *buflen, &msglen);

 }

return (rc);
}

/*********************************************************
*                        FIND MESSAGE
*     Check that the complete message is at the start of
*     the buffer.
* 1.  Check the first 8 characters which are the message
*     length
```

```
* 2.  Check the next 2 characters - Message Type
* 3.  Check that the complete message, as defined by
*     the "message length" field, is in the buffer.
*     Return codes:
*     0 = message incomplete
*     1 = message complete
*     -1 = error
*************************************************************/
static int FindMessage (char *buffer, int buflen, int *mlen)
{
  char charlen[GTS_LENFIELD+1];
  int intlen;

  *mlen = 0;

  /* IF THE LENGTH OF THE PASSED MESSAGE BUFFER
IS NOT GREATER THAN 10 CHARACTERS THEN
RETURN 'INCOMPLETE'. */
  if ( buflen < GTS_SOCKET_HEADER ) {
   return (0);
   }


  /* CHECK THAT THE MESSAGE TYPE IS VALID */
     if (strncmp(buffer+GTS_LENFIELD,"AN",2) &&
strncmp(buffer+GTS_LENFIELD,'BI",2) && strncmp
(buffer+GTS_LENFIELD,"FX',2)) {
   printf("ERROR: Message Type field invalid');
   return (-1);
   }

  /* EXTRACT THE MESSAGE LENGTH */
  strncpy (charlen, buffer, GTS_LENFIELD);
  charlen[GTS_LENFIELD] = '\0';

  /* CHECK THAT THE MESSAGE LENGTH CHARACTER
STRING COMPRISES ENTIRELY OF DIGITS. RETURN
AN ERROR IF THIS IS NOT THE CASE. */
  if ( strspn (charlen, "0123456789") != strlen (charlen)) {
   printf("ERROR: length not numeric");
   return (-1);
   }

   /* CONVERT THE MESSAGE LENGTH CHARACTER
STRING TO AN INTEGER. */
  intlen = atoi (charlen);

   /* CHECK THAT THE LENGTH EXTRACTED FROM
THE BUFFER IS NOT GREATER THAN THE GTS
DEFINED MAXIMUM MESSAGE SIZE – RETURN AN
ERROR IF THIS IS THE CASE. */
  if ( intlen > MAX_MSGSIZE ) {
   printf("ERROR: message overlength");
   return (-1);
   }

    /* CHECK IF THE ENTIRE MESSAGE HAS BEEN
RECEIVED. RETURN IF NOT */
  if ( buflen < intlen + GTS_SOCKET_HEADER ) {
   return (0);
   }

  *mlen = intlen;
  return (1);
}

/*************************************************************
*                    CHECK MSG BOUNDARIES
*  Confirm the first character after the Socket Header is
*  a SOH, and the last character in the message (given
*  by the message length) is an ETX.
*************************************************************/
static int CheckMsgBoundaries (char *buffer, int msglen)
{

  /* CHECK THAT THE FIRST CHARACTER (AFTER THE
MESSAGE LENGTH FIELD) IS AN SOH CHARACTER -
RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[GTS_SOCKET_HEADER] != SOH ) {
   printf("ERROR: SOH not found\n");
   return (-1);
   }

   /* CHECK THAT THE LAST CHARACTER (ACCORD-
ING TO THE MESSAGE LENGTH FIELD) IS AN ETX
CHARACTER - RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[msglen+GTS_SOCKET_HEADER-1] != ETX )
{
   printf("ERROR: ETX not found\n");
   return (-1);
   }

  return (1);
}

/*************************************************************
*                         SHIFT BUFFER
*  Shift the leading message in the buffer out of the
*  buffer. This may either empty the buffer, or move all
*  or part of a new message to the start of the buffer.
*************************************************************/
static void ShiftBuffer (char *buffer, int *buflen, int
msglen)
{
  int shiftlen;

  /* CALCULATE THE AMOUNT OF DATA TO BE SHIFT-
ED OUT OF THE BUFFER. */
  shiftlen = msglen + GTS_SOCKET_HEADER;

    /* SHIFT THE 'PROCESSED' DATA OUT OF THE
BUFFER BY MOVING THE
   UNPROCESSED DATA OVER THE TOP OF IT.
    CALCULATE THE NEW AMOUNT OF DATA IN THE
BUFFER. */
  *buflen = *buflen - shiftlen;
  memcpy (buffer, buffer + shiftlen, *buflen);
}
```

3. REFERENCE MATERIAL

General references on TCP/IP

1. *Internetworking TCP/IP* Vol. 1 (2/E) – Douglas Comer – Prentice Hall.
2. *TCP/IP Illustrated* Vol. 1. – Stevens – Addison-Wesley.
3. *TCP/IP Architecture, Protocols and Implementation* – Feit – McGraw Hill.
4. *TCP/IP and Related Protocols* – Black – McGraw Hill.
5. *TCP/IP Running a Successful Network* – Washburn and Evans – Addison-Wesley.
6. *TCP/IP and ONC/NFS (2/E)* – Santifaller – Addison-Wesley.
7. *Inside TCP/IP* – Arnett, *et. al.* – New Riders Publishing.
8. *Teach Yourself TCP/IP in 14 Days* – Parker – SAMS.
9. I*ntroduction to TCP/IP* – Davidson – Springer.

References on security

1. *Firewalls and Internet Security* – Cheswick & Bellovin – Addison-Wesley.
2. *Practical Unix Security* – Garfinkel & Spafford – O'Reilly.
3. *Internet RFC 2196 (Site Security Handbook).*

4. SUGGESTED PASSWORD MANAGEMENT PRACTICES

Passwords are the system's first line of defence against unauthorized intrusion. While it is possible to violate system security without logging in, a poorly protected or chosen password can make a hacker's task a lot easier.

GOOD PASSWORDS:

1. Have both upper-case and lower case letters, and/or
2. Have digits and/or non-alphanumeric characters.
3. Are six to eight characters long.
4. Should consist of at least two words or groups of characters.
5. Should not be shared or used by more than one user.
6. Should not be used on more than one computer.
7. Should be changed regularly, e.g. monthly.
8. Can be typed quickly and easily, so that an observer cannot follow the keystrokes.
9. Are easy to remember — so that they should not have to be written down.

BAD PASSWORDS:

1. The name of: yourself, your spouse, your children, your parents, your pet, your friends, your favourite film stars/characters, anyone associated with you, your workstation or its host.
2. The number of: your telephone, your car's license plate, your user ID, any part of your credit cards' numbers, or any number associated with you.
3. The birthday of yourself or anyone associated with you.
4. Any word from any dictionary, any place name, any proper noun.
5. The name of a well known public identity such as a sporting hero, entertainer or well known fictional character.
6. Simple patterns: aaaaaaa, qwerty.
7. Any of 1–6 spelled backwards.
8. Any of 1–6 preceded or followed by a digit.
9. Any password that has been written down and left in an unlocked drawer or unsecured computer file.
10. Any password that has been on a machine that may have been successfully hacked (except as part of authorised exercises).
11. Any password on a machine that has been left unattended when any user is logged on.

PART III

Amend paragraphs 1.3 and 1.4 to read:

1.3 The circuits of the Main Telecommunication Network shall be implemented by using efficient telecommunication services and facilities, including digital or analogue dedicated leased circuits, frame relay services and managed data-communication network services, based on relevant ITU-T Recommendations.

1.4 Analogue dedicated leased circuits (i.e. telephone-type circuits) shall be operated with modems in conformity with relevant ITU-T Recommendations. Modems in conformity with ITU-T Recommendation V.34 are recommended.

Delete sections 2 and 6 and renumber subsequent sections accordingly.

Amend new section 2 as follows:

ENGINEERING OF WMCs AND RTHs ON THE MAIN TELECOMMUNICATION NETWORK

WMCs and RTHs on the Main Telecommunication Network shall be capable of operating as a node on the MTN and providing the necessary gateway functions with the relevant regional meteorological telecommunication network.

Delete Attachments III-1 and III-2.

RECOMMENDATION 3 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) The report of the ninth session of the CBS Working Group on Data Processing (November 1997),

(2) The conjoint WMO/CTBTO and WMO/IAEA Expert Meeting on EER (December 1997, Vienna, Austria),

(3) The *Manual on the Global Data-processing System* (WMO-No. 485),

CONSIDERING:

(1) That there is a need to clarify further NWP verification procedures,

(2) That there is a need to specify WMC Washington as an RSMC with geographical specialization in accordance with its accepted functions,

(3) That there is a need to refine the arrangements for the provision of meteorological assistance to United Nations humanitarian missions,

(4) That there is a need in the light of experience to update current procedures for the provision of transport model products for environmental emergency response,

(5) That there is a need as a consequential amendment for additions to Appendix II-4 to be used to represent on weather charts, $w_a w_a$ additional parameters,

RECOMMENDS that the amendments to the *Manual on the Global Data-processing System* (WMO-No. 485), Appendix I-1, Attachment II-7, Appendix I.5, Appendix I.3, Appendix II-4, and Appendix II-7, given in the annexes to this recommendation, be adopted for inclusion in the *Manual on the Global Data-processing System* (WMO-No. 485) to take effect from 1 July 1999;

REQUESTS the Secretary-General, to make appropriate changes, as given in the annexes to this recommendation in the *Manual on the Global Data-processing System* (WMO-No. 485);

AUTHORIZES the president of CBS, in consultation with the Secretary-General to make any consequent purely editorial amendments with respect to the *Manual on the Global Data-processing System* (WMO-No. 485).

ANNEX 1 TO RECOMMENDATION 3 (CBS-Ext.(98))

PROPOSED AMENDMENTS TO ATTACHMENT II.7, TABLE F OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

Factors and methods used in standardized verification of NWP products

---

I – Verification against analysis

Area	Northern hemisphere extratropics (90°N – 20°N) (all inclusive) Tropics (20°N – 20°S) (all inclusive) Southern hemisphere extratropics (20°S – 90°S) (all inclusive)
Grid	Verification analysis is the centre's on a latitude–longitude grid 2.5° ¥ 2.5°; origin (0°, 0°)
Variables	Mean sea-level pressure, geopotential height, temperature, winds
Levels	Extratropics: Mean sea-level, 500 hPa, 250 hPa Tropics: 850 hPa, 250 hPa
Time	24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, 240 h ...
Statistics	Mean error, root-mean-square error (rmse), anomaly correlation, S_1 skill score, root-mean-square vector wind error ($rmse_v$)

The following definitions should be used:

mean error $$M_{f,v} = \frac{\sum_{i=1}^{n} (x_f - x_v)_i \cos\varphi_i}{\sum_{i=1}^{n} \cos\varphi_i}$$

rms error $$rmse = \sqrt{\frac{\sum_{i=1}^{n} (x_f - x_v)_i^2 \cos\varphi_i}{\sum_{i=1}^{n} \cos\varphi_i}}$$

correlation coefficient between observed and forecast anomalies

$$r = \frac{\sum_{i=1}^{n} (x_f - x_c - M_{f,c})_i (x_v - x_c - M_{v,c})_i \cos\varphi_i}{\sqrt{\sum_{i=1}^{n} (x_f - x_c - M_{f,c})_i^2 \cos\varphi_i} \cdot \sqrt{\sum_{i=1}^{n} (x_v - x_c - M_{v,c})_i^2 \cos\varphi_i}}$$

rms vector wind error $$rmse_v = \sqrt{\frac{\sum_{i=1}^{n} (\vec{V}_f - \vec{V}_v)_i^2 \cos\varphi_i}{\sum_{i=1}^{n} \cos\varphi_i}}$$

S_1 skill score (for mean sea-level pressure and geopotential height only)

$$S_1 = 100 \cdot \frac{\sum_{i=1}^{n} (e_g)_i \cos\varphi_i}{\sum_{i=1}^{n} (G_L)_i \cos\varphi_i}$$

where: x_f = the forecast value of the parameter in question;

x_v = the corresponding verifying value (analysed);

n = the number of grid points in the verification area;

$\cos \varphi_i$ = cosinus of latitude of grid point i;

x_c = the climatological value of the parameter;

$M_{f,c}$ = the mean value over the verification area of the forecast climate anomalies;

$M_{v,c}$ = the mean value over the verification area of the analysed climate anomalies;

$\vec{V}_f$ = the forecast wind vector;

$\vec{V}_v$ = the verifying (analysed) wind vector.

$$e_g = \left\{ \left| \frac{\partial}{\partial x}(x_f - x_v) \right| + \left| \frac{\partial}{\partial y}(x_f - x_v) \right| \right\}$$

$$G_L = \max \left[\left| \frac{\partial x_f}{\partial x} \right|, \left| \frac{\partial x_v}{\partial x} \right| \right] + \max \left[\left| \frac{\partial x_f}{\partial y} \right|, \left| \frac{\partial x_v}{\partial y} \right| \right]$$

where the differentiation is approximated by differences on a 2.5° × 2.5° latitude/longitude grid.

NOTES:

(1) Values for these statistics should be computed daily (0000 UTC and 1200 UTC separately) for each specified area. Monthly averages should then be computed from the daily values of all forecasts verifying within the relevant month. For those centres not running forecasts from either 0000 or 1200 UTC, tables may alternatively be provided for 0600 UTC and 1800 UTC and should be labelled as such.

(2) The number of runs (daily statistics) forming the monthly means should be exchanged in the monthly report.

(3) Annual averages of daily verification are inlcuded in the yearly *Technical Progress Report on the Global Data-processing System*. These statistics are for the 24, 72 and 120 h forecast and include the rms vector wind error at 850 hPa (tropics area only) and 250 hPa (all three areas) as well as the rms error of geopotential heights at 500 hPa (northern and southern hemispheres).

(4) To the extent possible, horizontal and vertical interpolations from model to verifying grids should not involve multiple steps or explicit smoothing.

II – Verification against observations

Network: The seven networks used in verification against radiosondes consist of radiosondes stations lying within the following geographical area:

North America	25°N–60°N	50°W–145°W
Europe/North Africa	25°N–70°N	10°W –28°E
Asia	25°N–65°N	60°E–145°E
Australia/New Zealand	10°S–55°S	90°E–180°E
Tropics	20°S–20°N	all longitudes
Northern hemisphere extratropics	20°N–90°N	all longitudes
Southern hemisphere extratropics	20°S–90°S	all longitudes

Stations: The list of radiosonde stations to be used in each network is updated annually by the lead centre for radiosondes. The chosen stations must be available to all the centres and provide quality data on a regular basis. Consultation with all centres (usually by electronic mail) is desirable before establishing the final list. This list is published in the monthly WWW *Operational Netwsletter*, as appropriate.

Variables: Geopotential height, temperature, winds

Levels: 850 hPa, 500 hPa, 250 hPa

Time: 24 h, 48 h, 72 h, 96 h, 120 h, 144 h, 168 h, 192 h, 216 h, 240 h ...

Statistics: Mean error, root-mean-square error (rmse), trend correlation, root-mean-square vector wind error ($rmse_v$)

The following definitions should be used:

mean error $$M_{f,v} = \frac{1}{n}\sum_{i=1}^{n}(x_f - x_v)_i$$

rms error $$rmse = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_f - x_v)_i^2}$$

correlation coefficient between observed and forecast trends

$$r = \frac{\sum_{i=1}^{n}(x_f - x_{f_o} - M_{f,f_o})_i (x_v - x_{v_o} - M_{v,v_o})_i}{\sqrt{\sum_{i=1}^{n}(x_f - x_{f_o} - M_{f,f_o})_i^2} \cdot \sqrt{\sum_{i=1}^{n}(x_v - x_{v_o} - M_{v,v_o})_i^2}}$$

rms vector wind error $$rmse_v = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(\vec{V}_f - \vec{V}_v)_i^2}$$

where: x_f = the forecast value of the parameter in question;

x_v = the corresponding verifying value (observed);

x_{f_o}, x_{v_o} = same as above, but for the initial time;

n = the number of observations in the verification area;

M_{f,f_o} = the mean value over the verification area of the forecast trends;

M_{v,v_o} = the mean value over the verification area of the observed trends;

$\vec{V}_f$ = the forecast wind vector;

$\vec{V}_v$ = the verifying (observed) wind vector.

NOTES:

(1) The observations used for verification should be screened to exclude those with large errors. In order to do this, it is recommended that centres exclude values rejected by their objective analysis. Moreover, centres which apply a correction to the observations received on the GTS to remove biases (e.g. radiation correction), should use the corrected observations to compute statistics.

(2) Values for these statistics should be computed daily (0000 UTC and 1200 UTC separately) for each specified network. Monthly averages should then be computed from the daily values of all forecasts verifying within the relevant month. For those centres not running forecasts from either 0000 or 1200 UTC, tables may alternatively be provided for other base times and should be labelled as such.

(3) The number of runs (daily statistics) forming the monthly means should be exchanged in the monthly report, as well as the average number of observation points used in the computations.

(4) Annual averages of daily verification are inlcuded in the yearly *Technical Progress Report on the Global Data-processing System*. These statistics are for the 24, 72 and 120 h forecast and include the rms vector wind error at 850 hPa (tropics network only) and 250 hPa (all seven networks) as well as the rms error of geopotential heights at 500 hPa (all the networks except for tropics). A table of the number of observations per month should also be part of the yearly report.

(5) To the extent possible, horizontal and vertical interpolations from model to verifying observations should not involve multiple steps or explicit smoothing.

ANNEX TO TABLE F

Content and format of monthly verification report

A report is prepared each month by the centres and exchanged electronically among the participants. The prescribed content and format have followed closely in order to facilitate the processing of verification data at the receiving end of the communication.

Content

A – Verification against analysis

Each region is represented by the table first number:

TABLE 1.x NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)
TABLE 2.x TROPICAL VERIFICATION AGAINST ANALYSIS (20°N–20°S)
TABLE 3.x SOUTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°S)

Within each region specific table numbers are assigned to variables and levels.

For northern and southern hemispheres (Tables 1.x and 3.x):

TABLE x.1 MEAN SEA LEVEL PRESSURE
TABLE x.2 500 HPA GEOPOTENTIAL HEIGHT
TABLE x.3 250 HPA GEOPOTENTIAL HEIGHT
TABLE x.4 500 HPA TEMPERATURE
TABLE x.5 250 HPA TEMPERATURE
TABLE x.6 500 HPA WIND
TABLE x.7 250 HPA WIND
TABLE x.8 and more reserved

For tropics (Tables 2.x):

TABLE 2.1 850 HPA GEOPOTENTIAL HEIGHT
TABLE 2.2 250 HPA GEOPOTENTIAL HEIGHT
TABLE 2.3 850 HPA TEMPERATURE
TABLE 2.4 250 HPA TEMPERATURE
TABLE 2.5 850 HPA WIND
TABLE 2.6 250 HPA WIND
TABLE 2.7 and more reserved

B – Verification against observations

Each network is represented by the table first number:

TABLE 4.x NORTH AMERICA VERIFICATION AGAINST RADIOSONDES
TABLE 5.x EUROPE/NORTH AFRICA VERIFICATION AGAINST RADIOSONDES
TABLE 6.x ASIA VERIFICATION AGAINST RADIOSONDES
TABLE 7.x AUSTRALIA/NEW ZEALAND VERIFICATION AGAINST RADIOSONDES
TABLE 8.x TROPICS VERIFICATION AGAINST RADIOSONDES
TABLE 9.x NORTHERN EXTRATROPICS VERIFICATION AGAINST RADIOSONDES
TABLE 10.x SOUTHERN EXTRATROPICS VERIFICATION AGAINST RADIOSONDES

Within each region specific table numbers are assigned to variables and levels:

TABLE x.1 850 HPA GEOPOTENTIAL HEIGHT
TABLE x.2 500 HPA GEOPOTENTIAL HEIGHT
TABLE x.3 250 HPA GEOPOTENTIAL HEIGHT
TABLE x.4 850 HPA TEMPERATURE
TABLE x.5 500 HPA TEMPERATURE
TABLE x.6 250 HPA TEMPERATURE
TABLE x.7 850 HPA WIND
TABLE x.8 500 HPA WIND
TABLE x.9 250 HPA WIND
TABLE x.10 and more reserved

Format

Format of exchange of WMO standards scores by electronic media

(Examples of a number of tables are given)

```
Columns
0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

                                VERIFICATION TO WMO STANDARDS
                    ---------------------------------------------------------------------------
                        CENTRE NAME                          MMMMMMMMM  YYYY
                    ---------------------------------------------------------------------------
                                MODEL NAME AND CHARACTERISTICS
                    ---------------------------------------------------------------------------

# Comment line : missing cases must be reported here.
# Comment line

TABLE 1.1          NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)
                    ---------------------------------------------------------------------------
                        MEAN SEA LEVEL PRESSURE                  SEPTEMBER 1997
                    ---------------------------------------------------------------------------

 FORECAST      MEAN ERROR          RMSE              ANOM. CORR.          SKILL SCORE
  PERIOD          (hPa)            (hPa)            ---------------------  ---------------------
 -------------  0000 UTC 1200 UTC  0000 UTC 1200 UTC  0000 UTC 1200 UTC  0000 UTC 1200 UTC
 (HOURS)        -------- --------  -------- --------  -------- --------  -------- --------
 24             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 48             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 72             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 96             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
120             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
144             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
168             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
192             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
216             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
240             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx

TABLE 1.2          NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)
                    ---------------------------------------------------------------------------
                        500 HPA GEOPOTENTIAL HEIGHT              SEPTEMBER 1997
                    ---------------------------------------------------------------------------

 FORECAST      MEAN ERROR          RMSE              ANOM. CORR.          SKILL SCORE
  PERIOD          (m)              (m)              ---------------------  ---------------------
 -------------  0000 UTC 1200 UTC  0000 UTC 1200 UTC  0000 UTC 1200 UTC  0000 UTC 1200 UTC
 (HOURS)        -------- --------  -------- --------  -------- --------  -------- --------
 24             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 48             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 72             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
 96             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
120             xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx   xxxxxxx  xxxxxxx
etc.

0         1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
```

- n1 blank line see note 4
- File header see note 1
- n2 blank line see note 4
- Table header 11 lines see note 2
- m data line see note 3
- n3 blank line see note 4

Columns
0 1 2 3 4 5 6 7 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789

TABLE 1.4 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

500 HPA TEMPERATURE SEPTEMBER 1997

FORECAST PERIOD (HOURS)	MEAN ERROR (K) 0000 UTC	MEAN ERROR (K) 1200 UTC	RMSE (K) 0000 UTC	RMSE (K) 1200 UTC	ANOM. CORR. 0000 UTC	ANOM. CORR. 1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
etc.						

TABLE 1.6 NORTHERN HEMISPHERE VERIFICATION AGAINST ANALYSIS (20–90°N)

500 HPA WIND SEPTEMBER 1997

FORECAST PERIOD (HOURS)	MEAN SPEED ERROR (m/s) 0000 UTC	MEAN SPEED ERROR (m/s) 1200 UTC	RMSEV (m/s) 0000 UTC	RMSEV (m/s) 1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
etc.				

TABLE 4.1 NORTH AMERICA VERIFICATION AGAINST RADIOSONDES

850 HPA GEOPOTENTIAL HEIGHT SEPTEMBER 1997

FORECAST PERIOD (HOURS)	MEAN ERROR 0000 UTC	MEAN ERROR 1200 UTC	RMSE 0000 UTC	RMSE 1200 UTC	TREND CORR. 0000 UTC	TREND CORR. 1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
etc.						

TABLE 4.7 NORTH AMERICA VERIFICATION AGAINST RADIOSONDES

850 HPA WIND SEPTEMBER 1997

FORECAST PERIOD (HOURS)	MEAN SPEED ERROR 0000 UTC	MEAN SPEED ERROR 1200 UTC	RMSEV 0000 UTC	RMSEV 1200 UTC
24	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
48	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
72	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
96	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
120	xxxxxxx	xxxxxxx	xxxxxxx	xxxxxxx
etc.				

NUMBER OF OBSERVATIONS USED 0000 UTC = xxxx 1200 UTC = xxxx – see note 7

0 1 2 3 4 5 6 7 8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

NOTE 1: (File header)
Underlining is optional.
Line 1: Fixed title (A80).
Line 4, columns 17 to 48: Centre name.
Line 4, columns 49 to 64: Month and year in full (6X, A32, AI6).
Line 7: Model name or characteristics (A80).

NOTE 2: (Table header)
Underlining is optional.
Line 1, columns 11 to 16: Table number.
Line 1, columns 17 to 80: Table name (10X, F6.0, A64).
Line 3, columns 17 to 48: Parameter name.
Line 3, columns 49 to 64: month and year in full (16X, A32, AI6).
Line 7: Score names (10X, 4 (IX, A16)).
Line 8: Units (optional) (10X, 4 (IX, A16)).
Line 9: Times (10X, 4 (2X, A7, IX, A7).

NOTE 3: (Data lines)
m depends on forecast length.
Examples of specifying data are given.
xxxxxxx represents any numeric value.
Missing data should be left blank.
Reading data: (IX, I5, 4X, 4 (2X, F7.0, IX, F7.0)).
Searching for missing data: (10X, 4 (2X, A7, 1X, A7)).

NOTE 4:
n1, n2, n3 may be variable.

NOTE 5:
A line beginning # is treated as a comment.
A comment line should not occur within the file header, table header, or between data lines.
Comment lines can be used to give information on abnormal events, and/or any significant changes introduced into the NWP system during the month.
*
Missing cases must be reported in comment lines after the file header.

NOTE 6: All characters should be in ASCII representation.

NOTE 7: (Number of observations used).
Reading data: (57X, I4, 12X, I4).

* Proposed modification to current procedures.

ANNEX 2 TO RECOMMENDATION 3 (CBS-Ext.(98))

PROPOSED AMENDMENT TO APPENDIX I-1 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

LOCATION OF WMCs AND RSMCs WITH GEOGRAPHICAL SPECIALIZATION AND RMSCs WITH ACTIVITY SPECIALIZATION

Insert in paragraph 2, Washington in the list of RSMCs with geographical specialization.

ANNEX 3 TO RECOMMENDATION 3 (CBS-Ext.(98))

PROPOSED AMENDMENTS TO APPENDIX I.5 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

ARRANGEMENTS FOR THE PROVISION OF METEOROLOGICAL ASSISTANCE TO UNITED NATIONS HUMANITARIAN MISSIONS

The United Nations/Department of Humanitarian Affairs (UN/DHA) shall normally request a service from the national Meteorological Service National Meteorological Centre (NMC) of the country concerned. If the NMC is not operational, this fact shall be confirmed to the associated RSMC with geographical specialization when requesting a service. DHA shall also specify details of the area or location for which service is required ~~and location of recipient of information if different from DHA Headquarters operations centre~~. The NMCs or RSMCs usually provide the products to the UN/DHA Headquarters operation centre. The RSMCs zones of responsibility are as specified in the annex to this appendix.

The NMC shall:

Upon receipt of a request from UN/DHA, provide to DHA or its designated recipient location, basic meteorological and climate information and forecasts. The products to be provided will be negotiated with UN/DHA, but could ~~This information will~~ consist of 72 hour public weather forecasts, severe weather advisories and warnings longer-range outlooks, and may include climate information for specified areas or locations in support of humanitarian missions.

The WMO Secretariat shall:

(*a*) Upon request, from UN/DHA, arrange ~~provide~~ guidance in interpretation of specialized meteorological information and products made available by NMCs or RSMCs ~~with specific activity specialization~~;

(*b*) Establish and maintain up-to-date NMCs operational contact points for assistance to UN humanitarian missions and make these available to UN/DHA and RSMCs.

(*c*) Establish and maintain up-to-date RSMCs contact points and their back-ups.

The RSMC with geographical specialization and its back-up for the relevant zone of responsibility shall:

~~(*a*) Upon receipt of a first request from UN/DHA, inform the WMO Secretariat and request the National Meteorological Service NMC, if it is still operational, to respond to the request directly or through the RSMC and provide the services stated in (2) below;~~

~~(*b*)~~ (*a*) Upon receipt of a request from UN/DHA with confirmation that the relevant national Meteorological Service NMC of a Member facing an emergency or in catastrophic distress and out of Service, provide to UN/DHA ~~or its designated recipient location~~, basic meteorological and climate information and forecasts. ~~This information will~~ The products to be provided will be negotiated with UN/DHA, but could consist of 72 hour public weather forecasts, severe weather advisories, and warnings, and longer-range outlook and may include climate information for specified areas or locations in support of humanitarian missions;

~~(*c*)~~ (*b*) For ongoing requirement determine in consultation with UN/DHA, relevant set of climate information, basic forecasts, their format and methods of delivery, location of delivery, depending on the nature of the situation;

~~(*d*) Make arrangements to provide back-up services.~~

Provision of forecasts from a remote RSMC is not an ideal arrangement and the quality of the forecasts can be expected to be reduced accordingly. The service provided should be accepted on the terms of a best effort basis and recognized as such by DHA.

SUPPORT FOR NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

REGIONAL ARRANGEMENTS

The RSMCs designated by WMO for the provision of atmospheric transport model products for nuclear environmental emergency response shall:

1. Provide products only when either the delegated authority[1] of any country in the RSMC region of responsibility or the International Atomic Energy Agency (IAEA) requests RSMC support. Upon receipt of a request from the delegated authority[2], the RSMC shall provide basic information to the national Meteorological Service of that country and to the IAEA. Receipt of a request from the IAEA constitutes a confirmation of a significant event and the RSMCs shall distribute products as provided in paragraph 3. This information will consist of an agreed set of basic products; the delegated authority will be named by each country through the Permanent Representative of the country with WMO.

2. Upon receipt of a first request related to ~~an event~~, **a nuclear incident** inform the WMO Secretariat and all designated RSMCs of the request **and** ~~3. Upon receipt of a request related to the nuclear incident~~, inform IAEA of such request if the event has not yet been confirmed by IAEA.

3. After confirmation of a significant incident ~~event (by IAEA for radiological events and through other means for other emergencies)~~(**by IAEA's request for basic products**), distribute basic information to all national Meteorological Services in the region[3]. If the ~~event~~ **incident** has not been confirmed by IAEA, basic information provided to the national Meteorological Service of the requesting country will not be disclosed to the public in that country nor distributed by RSMCs to other national Meteorological Services.

4. ~~For radiological emergencies~~, Provide, on request, support

Association IV-designated RSMCs be responsible to provide services to Regional Association III; while the Regional Association V-designated RSMC, in collaboration with Regional Association IV-designated RSMCs, will be responsible to provide services to Regional Association V.

In cases of radiological emergencies where coordination is required between RSMCs of different regions, the RSMCs of the region where the emergency has occurred will provide this coordination.

In the event of an actual or apprehended nuclear incident, the IAEA shall provide the timely authoritative notification to RSMCs and WMO that its emergency response system has returned to normal mode and no longer requires the assistance of RSMCs. RSMCs will also notify NMSs of termination of their special activities, as appropriate.

SUPPORT FOR NON-NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

In the event that support is required for response to a non-nuclear environmental emergency, the Permanent Representative with WMO of the affected country may direct its request for support to the operational contact point of the designated RSMC(s) specialized in EER for its Regional Association.

1. **Due to the potentially broad range of environmental emergencies, the RSMC shall consider each request with regard to its capabilities and the suitability of its products to address the emergency requirements and will then respond accordingly.**
2. **The RSMC shall inform all other RSMCs specialized in EER and the WMO Secretariat of the request and the agreed actions.**

ANNEX 5 TO RECOMMENDATION 3 (CBS-Ext.(98))

PROPOSED AMENDMENTS TO APPENDIX II-7 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

STANDARDS IN THE PROVISION OF INTERNATIONAL SERVICES BY RSMCS FOR NUCLEAR ENVIRONMENTAL EMERGENCY RESPONSE

The Delegated Authority requests for WMO Regional Specialized Meteorological Centres (RSMC) support for atmospheric transport modelling products by using the form entitled "Environmental Emergency Response Alert — Request for WMO RSMC Support by Delegated Authority". The Delegated Authority then sends the completed form immediately to the RSMCs as per the regional and global arrangements.

The designated RSMCs shall implement agreed standard procedures and products by:

(*a*) The adoption of the following common default source parameters for the initial run of the transport/dispersion models;

(*b*) The provision of the following standard set of basic products within two to three hours of reception of a request and according to the general rules for displaying results;

(*c*) The adoption of the following forecast periods for the numerical calculations;

(*d*) The adoption of a joint response approach;

(*e*) The adoption of the general rules for displaying results.

1. Default source parameters for the initial run[4]:

(*a*) Uniform vertical distribution up to 500 m above the ground;

(*b*) Uniform emission rate during six hours;

(*c*) Starting time 0000 UTC or 1200 UTC if not known;

(*d*) Total pollutant release ~~1 unit (arbitrary)~~ **1 Bq (Becquerel)**;

(*e*) Type of radionuclide CS 137.

2. Standard set of products for initial response

Five maps consisting of:

(*a*) Three-dimensional trajectories starting at 500, 1 500 and 3 000 m above the ground, with particle locations at **6h intervals (main** synoptic hours up to the end of the dispersion model forecast);

(*b*) Time-integrated ~~pollutant~~ **air borne** concentrations within the layer 500 m above the ground, in ~~Unit.s~~ **Bq.s** m^{-3} for each of the three forecast periods;

(*c*) Total deposition (wet + dry) in ~~Unit~~ **Bq** m^{-2} from the release time to the end of the dispersion model forecast.

Previously transmitted products from the dispersion model need not be re-transmitted.

3. Forecast periods for numerical calculations

The initial set of products will cover the period from T, the start time of the release, through a forecast of 72 hours from t, the start time of the current output from the operational NWP model.

The first 24-hour period for integrated exposures in the dispersion model will start at the nearest synoptic

4 This concept is based on the understanding that the first (initial) run of the transport/dispersion models needs to be carried out with default parameters because little or no information (except location and accident time) will be available to the RSMC at this early stage. RSMCs are, however, requested to conduct subsequent model runs with more realistic parameters as they become available. This may, for example, refer to a more precise assumption of the vertical distribution or the need to conduct a model run for the release of noble gases.

time (0000 or 1200 UTC) prior to or equal to T. Subsequent 24-hour integrations of the dispersion model will be made up to, but not exceeding, the synoptic time nearest to t+72.

If T is earlier than t, the first response will use hindcasts to cover the period up to t. Results from the hindcasts need not be transmitted.

4. Joint response and joint statements

A joint response means that the two collaborating RSMCs shall immediately inform each other of any request received; initially both should produce and send the standard set of products (charts) independently and then move rapidly towards providing fully coordinated response and services for the duration of the response. Following the initial response, the RSMCs shall develop and provide, and update as required, a "joint statement" to describe a synopsis of the current and forecast meteorological conditions over the area of concern, and the results from the transport models, their differences and similarities and how they apply to the event.

5. General rules for displaying results

In order to make the interpretation of the maps easier, the producing centres should adopt the following guidelines:

General guidelines for all maps:

(*a*) Provide labelled latitude and longitude lines at 10° intervals and sufficient geographic map background (shore lines, country borders, etc.) to be able to locate precisely the trajectories and contours;

(*b*) Indicate the source location with a highly visible symbol (●, ▲, ✕, ✶, ✻, ■, etc.);

(*c*) Indicate the source location (latitude – N or S specified, longitude – E or W specified, plotting symbol used), date/time of release (UTC), and ~~where possible~~, the meteorological model initialization date/time (UTC);

(*d*) Each set of maps should be uniquely identified (e.g. product issue date and time).

Specific guidelines for trajectories map:

(*a*) Distinguish each trajectory (500, 1 500, 3 000 m) with a symbol (▲, ●, ■, etc.) at synoptic hours (UTC);

(*b*) Use solid lines (darker than map background lines) for each trajectory;

(*c*) Provide a time-height (m or hPa) diagramme, preferably directly below the trajectory map, to indicate vertical movement of trajectory parcels.

Specific guidelines for concentration and deposition maps:

(*a*) Adopt a maximum of four concentration/deposition contours corresponding to powers of 10;

(*b*) A legend should indicate that contours are identified as powers of 10 (i.e., –12 = 10^{-12}). If grey-shading is used between contours, the individual contours must be clearly distinguishable after facsimile transmission and a legend provided on the chart;

(*c*) Use solid dark lines (darker than map background lines) for each contour;

(*d*) Indicate with a legend if this is an exercise, an unconfined event or an IAEA confirmed event and indicate the following input characteristics: (i) source assumption (height, duration, isotope, amount released); (ii) the units of **time integrated** concentration (~~Units~~ **Bq.s** m^{-3}) or depositon (~~Unit~~ **Bq** m^{-2}). In addition, charts should specify: (i) "Time integrated surface to 500 m layer concentrations"; (ii) "Contour values may change from chart to chart"; and if the default source is used; (iii) "RESULTS BASED ON DEFAULT INITIAL VALUES";

(*e*) Indicate, if possible, the location of the maximum concentration/deposition with a symbol on the map and include a legend indicating the symbol used and maximum numerical value;

(*f*) Indicate the time integration starting and ending date/time (UTC).

The RSMCs will normally provide the products in the ITU-T T4 format suitable for both group 3 facsimile machines and transmission on parts of the GTS.

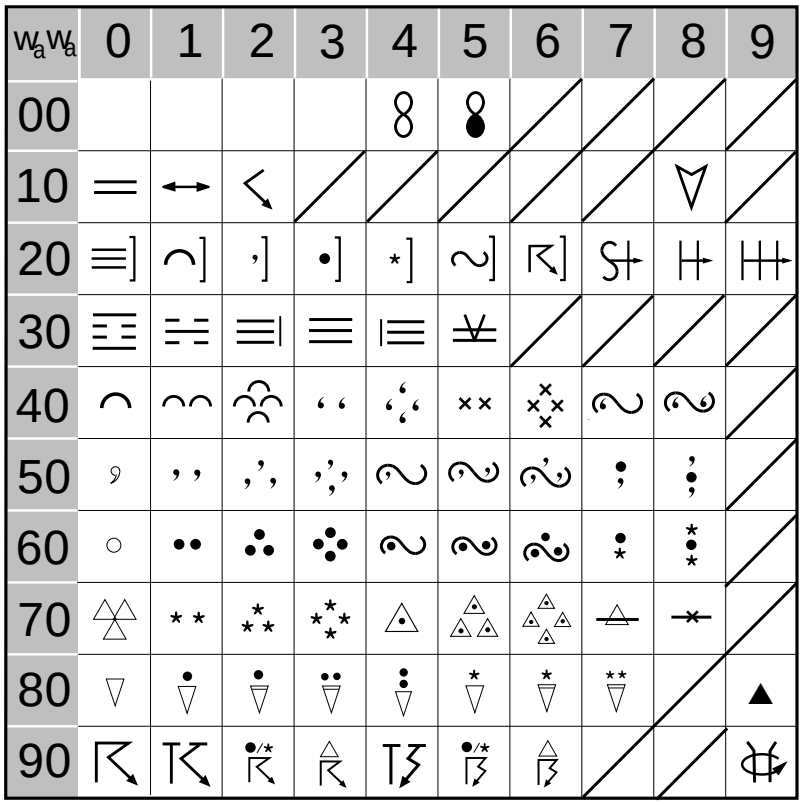
ANNEX 6 TO RECOMMENDATION 3 (CBS-Ext.(98))

PROPOSED AMENDMENTS TO APPENDIX II-4 OF THE *MANUAL ON THE GLOBAL DATA-PROCESSING SYSTEM* (WMO-No. 485)

Replace table $w_a w_a$ by the new table:

$w_a w_a$ Present weather reported from an automatic weather station (see Note 2)

The symbols for the appropriate code figures are given in the following table:



The symbols 30, 50, 60 and 70 represent the generic form of weather phenomena and may be plotted in an enlarged form.

The symbol ⌒ can specify any form of precipitation. ‚ specifies rain or drizzle. × specifies solid precipitation.

The symbols in row 80 represent intermittent precipitation, including showers.

NOTES: (1) The meaning of the code figures for present weather reported from an automatic station are given in Code table 4680 in the *Manual on Codes* (WMO-No. 306) (Annex II to the *Technical Regulations*).

(2) When present weather and past weather are not included because:

(*a*) They are not significant ($i_x = 5$), the squares for $w_a w_a$ and $W_{a1}W_{a2}$ are left blank;

(*b*) No observation was made ($i_x = 6$) or the data are missing ($i_x = 7$ but no 7-group in the message), $w_a w_a$ and $W_{a1}W_{a2}$ are both plotted as //.

RECOMMENDATION 4 (CBS-Ext. (98))

WMO/CTBTO COOPERATION IN AREAS RELATED TO METEOROLOGICAL MEASUREMENTS AND TRANSPORT MODELLING

THE COMMISSION FOR BASIC SYSTEMS,

RECALLING its decision as recorded in general summary paragraph 6.3.32(*d*) of the *Abridged Final Report with Resolutions and Recommendations of the Eleventh Session of the Commission for Basic Systems* (WMO-No. 854) on benefits that could be derived from the application of GDPS to other WMO and related international programmes such as the activities of the new CTBTO,

NOTING:

(1) The report of the ninth session of the CBS Working Group on Data Processing (November 1997),

(2) The outcome of the conjoint WMO/CTBTO Expert Meeting on CTBT Requirements and WMO/IAEA Environmental Emergency Response Activities (December 1997, Vienna, Austria),

(3) The outcome of the CBS Working Group on Data Processing/Task Group on WMO/CTBTO Matters (Geneva, July 1998),

(4) The *Manual on the Global Data-processing System* (WMO-No. 485), particularly functions of RSMCs with activity specialization in provision of transport model products for environmental emergency response,

CONSIDERING that:

(1) CTBTO radionuclide stations require on-site meteorological measurements and that WMO would benefit from CTBTO making available to WMO meteorological measurements from CTBTO remote locations, which have no nearby WMO observing stations,

(2) Meteorological measurements at infrasound stations will not meet WMO observing standards nor can nearby WMO meteorological stations be used by the CTBTO,

(3) The CTBTO International Data Center (IDC) will require access to meteorological data available on the GTS and gridded model output products,

(4) Radionuclide data, once associated with identified emissions or natural sources, can be used to improve and develop further the transport models,

(5) In the case of a confirmed nuclear explosion or detection of multiple fission products, the IDC may request predesignated RSMCs (similar to the current arrangements with the IAEA for nuclear accidents), to run their higher resolution meteorological models, to produce a set of predefined products, either from the source location, if known, or from designated sampling locations, if that is the only information,

(6) It may be possible to use the CTBTO VSAT to transmit local observations at meteorological sites near CTBTO stations to WMO,

RECOMMENDS that the CTBTO and WMO develop cooperation in areas related to meteorological measurements and transport modelling, by keeping each other informed on their respective activities and requirements in these matters. More specifically, the Commission recommends that:

(1) On-site meteorological measurements at CTBTO radionuclide stations should conform to WMO observing standards;

(2) CTBTO investigate the option of co-using suitably located WMO meteorological stations for radionuclide monitoring;

(3) Non-standard meteorological measurements at infrasound stations if made available beyond CTBTO users, should carry a disclaimer on their WMO non-standard nature;

(4) WMO and CTBTO develop arrangements to provide the RSMCs' gridded meteorological model output data to the CTBTO to support in-house modelling capabilities;

(5) CTBTO initially use the gridded forecast fields provided by the RSMCs as meteorological support to the CTBTO on-site inspection programme, and develop other arrangements as necessary later on;

(6) The CTBTO radionuclide observations be provided to RSMCs for validation and improvement of model products;

(7) A data link be established between CTBTO and a suitable NMC (e.g. Vienna) for the purpose of routine access to WMO surface observations and to inject CTBTO meteorological measurements into the GTS;

(8) WMO and CTBTO develop arrangements to provide to CTBTO transport model products from the RSMCs with activity specialization in environmental emergency response;

(9) WMO address CTBTO's request for RSMCs to provide transport models and other assistance to CTBTO to enhance their in-house capabilities;

(10) WMO, in consultation with WMO Members concerned, compile a list of their meteorological stations that have poor data collection facilities and are near CTBTO stations. Thereafter, WMO would invite CTBTO to consider the feasibility of using the CTBTO VSAT communications system to collect and inject those observations into the GTS by establishing the appropriate telecommunication links.

REQUESTS the Secretary-General to invite CTBTO to cooperate with WMO and take appropriate joint measures and give support to the related work, within the resources available, to assure mutual success in the implementation of this recommendation.

RECOMMENDATION 5 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON CODES* (WMO-No. 306), VOLUME I.2, PART C, COMMON FEATURES OF FM 95-XI Ext. CREX

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) Resolution 5 (CBS-XI) — Working Group on Data Management,

(2) The report of the meeting of the Subgroup on Data Representation and Codes (20–24 April 1998),

(3) The report of the third session of the Working Group on Data Management (8–12 June 1998),

(4) The *Abridged Final Report with Resolutions and Recommendations of the Eleventh Session of the Commission for Basic Systems* (WMO-No. 854), general summary paragraphs 6.4.10 and 6.4.34,

CONSIDERING the requirement:

(1) To avoid, through implementation of a new expandable and flexible table-driven character code, the proliferation of new alphanumeric code forms by permitting the exchange of observations, for which no traditional character code existed and which, for various reasons, could not be transmitted in BUFR,

(2) To facilitate migration to binary code such as BUFR, by offering an easy conversion between BUFR and a new table-driven character code, by keeping the respective sets of tables closely related,

RECOMMENDS that the new table-driven code form FM 95-XI Ext. CREX, defined in the annex to this recommendation, be adopted for use as from 3 May 2000;

REQUESTS the Secretary-General to arrange for the inclusion of this addition in Volume I.2 of the *Manual on Codes* (WMO-No. 306).

ANNEX TO RECOMMENDATION 5 (CBS-Ext.(98))

FM 95-XI Ext. CREX — A CHARACTER FORM FOR THE REPRESENTATION AND EXCHANGE OF DATA

CODE FORM:

SECTION 0	**Indicator section**
SECTION 1	**Data description section**
SECTION 2	**Data section**
SECTION 3	**(Optional section)**
SECTION 4	**End section**

NOTES:

(1) CREX is the name of a character code for the representation and exchange of meteorological and other data.

(2) CREX uses many of the principles of FM 94 BUFR.

(3) CREX may be used for the exchange of data for which there is no suitable existing WMO code form.

(4) A CREX message shall consist of one or more subsets of related meteorological data defined, described, and represented by a single CREX entity. For observational data, each subset shall correspond to one report.

(5) A CREX message consists of sections:

Section number	*Name*	*Contents*
0	Indicator section	'CREX'
1	Data description section	CREX Master table number, edition number, table version number, data category, then a collection of descriptors which define the form and content of data subsets making the data section, and an optional check digit indicator "E"
2	Data section	A set of data items defined by Section 1
3	Optional section	'SUPP' followed by additional items for local use
4	End section	'7777'

(6) It will be noted that CREX representation is suitable for the manual encoding and visual display of meteorological and other data.

REGULATIONS:

95.1 General

95.1.1 The beginning and ending of the data representation form shall be identified by the characters 'CREX' and '7777', respectively.

95.1.2 Information within CREX shall be character coded.

95.1.3 A group is a sequence of one or more contiguous characters corresponding to a single data descriptor or data value. Groups shall be separated from each other by one or more space characters. Multiple space characters shall be used when needed to improve human readability.

95.1.4 The subset terminator shall be represented by the character string '+'. The subset terminator shall not be used when the subset is the last subset.

95.1.5 The section terminator shall be represented by the character string '++. The section terminator shall additionally function as a subset terminator for the last subset.

95.2 Section 0 – Indicator section

95.2.1 Section 0 shall be 4 characters long consisting of the character sequence "CREX".

95.3 Section 1 – Data description section

95.3.1 The data description section shall begin with the CREX table descriptor starting with the letter T and followed by a 6 digit number (tteevv) without separator character. The first two digits (tt) shall define the CREX Master table used (tt = 00 if the standard WMO FM 95 CREX tables are used). The next two digits (ee) shall indicate the CREX edition number used and the last two digits (vv) shall indicate the CREX table version number used.

95.3.2 Immediately following the CREX table descriptor and a space character as separator, Section 1 shall contain a three-digit reference to CREX Table A, preceded by the letter A.

95.3.3 Data description syntax for CREX:

95.3.3.1 After the CREX table descriptor and the CREX Table A descriptor, Section 1 shall have one or more data descriptor(s). Data descriptors shall be preceded by a space character as separator. Data descriptors shall occupy 6 characters. Each descriptor shall have 3 parts: F(1 letter), xx(2 digits), yyy(3 digits).

95.3.3.2 The first part (F) of a data descriptor shall be either B, C, D or R.

95.3.3.3 If F = B, the descriptor shall function as "element descriptor", and it shall define a single data item by reference to CREX Table B named: Bxxyyy.

95.3.3.4 If F = C, the descriptor shall function as "operator descriptor", and it shall define an operation by reference to CREX Table C named: Cxxyyy.

95.3.3.5 If F = R, the descriptor shall function as "replication descriptor". The 2 digits "xx" shall define the number of following descriptors to be repeated the number of times defined by the 3 digits "yyy". If "yyy" equal "000", the descriptor defines a delayed replication. Delayed replication is the replication of data values of which the number of replication is known only in the observed report and will therefore be part of the data section (for example: number of levels in a sounding). A corresponding number of 4 digits in the data section shall then define the number of replication of the data values corresponding to the following xx descriptors in the data description section.

95.3.3.6 If F = D, the descriptor shall function as "sequence descriptor", and it shall define a list of element descriptors, replication descriptors, operator descriptors and/or sequence descriptors by reference to CREX Table D and named: Dxxyyy.

95.3.4 CREX Tables B shall define the element descriptors. If one entry in CREX Table B and one entry in BUFR Table B have the same table reference, the element name shall be the same in both tables. CREX Table B entries shall contain:

(*a*) The table reference (Bxxyyy);

(*b*) The element name (64 characters maximum);

(*c*) The units to be used for data representation in CREX, or instead, a reference to a Code Table or Flag Table which will then define the possible data value for the element;

(*d*) The scale factor to be applied to the data value for CREX purposes; the scale defines the precision of the value. No decimal points shall be used in the data section, so a positive scale means that so many figures after the decimal point are included (e.g. scale=2 means values coded in hundredths, e.g. height coded in centimeter). A negative scale means that so many figures before the decimal point are not included (e.g. heights in hundreds of meters would have scale = -2);

(*e*) The number of characters to be used in CREX to represent the corresponding data value (without counting the sign);

(*f*) Reference values for CREX element are always zero and there shall be no column for this attribute in CREX tables.

NOTE: Each entries in CREX Table B defining element descriptor should correspond in most of the cases with entries in BUFR Table B.

95.3.4.1 Units shall be based on either standard international units or standard common usage units used by the data producer and the users.

95.3.4.2 An operator descriptor shall be used to define change of unit, scale, or data width. The change shall apply only to the data value of the element referenced in the following element descriptor. The "yyy" digits of the operator descriptor shall define the new unit (yyy being equal to the code figure of the new unit defined in Common Code Table C-6 listing all the possible units), the new scale or the new data width. The original Table B unit, scale or data width shall be back in force again for that element when subsequently referenced in the data description section until a new change occurs.

NOTE: Change of unit, scale or data width should be avoided; it should be only a last resort solution. These changes are not recommended in a common CREX Table D sequence. The change operators should not be used when the end user of the message would be a human reader.

95.3.4.3 CREX Code Tables shall have the same code figures as BUFR Code Tables. As CREX Code Tables are generally longer than corresponding BUFR Code Tables (for example: 99 entries rather than 63), the value corresponding to 'Missing' and the values over within the BUFR Code Table shall be declared "Not used" within the corresponding CREX Table ('63' to '99' Not used in the example).

95.3.4.4 CREX Flag Tables shall be the same as BUFR Flag Tables. However, in CREX, Flag Tables shall be expressed using the octal representation in the following way: a set of three bits being represented by a figure from 0 to 7 (the leftmost bit being the first bit in the table rank), zeros being added on the left when the number of flags is not a multiple of 3:

000 = 0 (no bit set)
001 = 1 (bit 3 set)
010 = 2 (bit 2 set)
011 = 3 (bits 2 and 3 set)
100 = 4 (bit 1 set)
101 = 5 (bits 1 and 3 set)
110 = 6 (bits 1 and 2 set)
111 = 7 (all bits set).

For example, the seven flags table sequence "1100110" transformed with the addition on the left of two zeros to "001100110" would be translated to "146" in octal.

Missing value for a Flag Table shall be indicated by a set of solidi "/" covering the data width.

95.3.5 Element descriptors corresponding to the following classes in CREX Table B shall remain in effect until superseded by redefinition:

Class	
00	Reserved
01	Identification
02	Instrumentation
03	Reserved
04	Location (time)
05	Location (horizontal-1)
06	Location (horizontal-2)
07	Location (vertical)
08	Significance qualifiers
09	Reserved

NOTE: Redefinition is effected by the occurrence of element descriptors which contradict the preceding element descriptors from these classes. If two or more elements from the same class do not contradict one another, they all apply.

95.3.5.1 The consecutive occurrence of two identical element descriptors or identical sets of element descriptors from classes 04 to 07 inclusive shall denote a range of values bounded by the corresponding element values. This enables the definition of layers and simple time periods.

95.3.5.2 The definition of line, areas, volumes and more complex time attributes shall be accomplished using descriptors from class 04 to 07 in association with suitable descriptors from class 08.

95.3.5.3 The consecutive occurrence of two or more non-identical element descriptors from classes 04 to 07 inclusive shall infer that all such elements remain in effect until redefined, unless such elements define an increment.

95.3.5.4 Data items defined by element descriptors in class 10 or above shall not behave as coordinates with respect to subsequent data.

95.3.5.5 Any occurrence of an element descriptor from classes 04 to 07 inclusive which defines an increment shall indicate that the location corresponding to that class be incremented by the corresponding data value.

95.3.5.6 If a CREX message is made up of more than one subset, each subset shall be treated as though it was the first subset encountered.

95.3.6 A check digit indicator is optional at the end of section 1. If present, it shall take the form of the single character "E".

95.4 Section 2 – Data section

95.4.1 The data section shall be comprised of one or more subsets of groups. Each group shall represent one data value. The sequence of data values shall correspond in order to the list of descriptors defined by Section 1 and shall be terminated by subset terminator, or, in the case of the last subset, by the section terminator.

95.4.2 Each data value shall be coded using the number of characters defined in the CREX Table B entry of the corresponding direct element descriptor in Section 1 or of the corresponding element descriptor within a sequence of descriptors defined by a sequence descriptor in Section 1. If the data value is a number defining a delayed replication (descriptor "Rxx000" in section 1), it shall comprise 4 digits.

95.4.3 Each numerical data value shall include leading zeroes when the number of digits required to represent the value is smaller than the number of characters defined in the corresponding CREX Table B entry or for the delayed repetition number, to keep the number of characters representing the data value always equal to the original data width defined in CREX Tables or regulations, in order to facilitate the presentation alignment and the decoding process.

95.4.4 Positive numerical data values shall be unsigned. Negative numerical data values only shall be signed and represented with the negative sign immediately preceding the data value.

95.4.5 Each data value having unit defined as character shall include trailing blanks when the number of characters required to represent the data value is smaller than the number of characters defined in the corresponding CREX Table B entry, to keep the number of characters representing the data value always equal to the original data width defined in CREX Tables, in order to facilitate the presentation alignment and the decoding process.

95.4.6 A missing value shall be represented as a group of solidi "/" characters equal in number to the number of characters normally required to represent the value concerned.

95.4.7 If the check digit indicator "E" is present at the end of section 1, a check digit shall be added in front of each data value, immediately preceding the first character of each data value. The check digit shall take the value of the unit digit of the ordered number of the data value, counting along the data subset in which it is contained, starting from 0 (the digit increases from 0 to 9 cyclically). The check digit shall precede immediately the negative sign if the data value is negative.

95.5 Section 3 – Optional section

95.5.1 Section 3 is optional and if present, shall contain additional items as may be defined within each Centre for specific use.

95.5.2 Section 3, if present, shall start with the four character sequence "SUPP" and shall end with a section terminator.

95.6 Section 4 – End section

95.6.1 Section 4 shall be 4 characters long coded as '7777'. Section 4 shall not have a section terminator.

SPECIFICATIONS OF SECTIONS

NOTES:
(1) Each section contains one or more groups of characters separated by one separator character.
(2) In the following, each group is numbered as group 1, group 2 and so on, from the beginning of the section.

Section 0 – Indicator section

Group No.	*Contents*	*Meanings*
1	CREX	Beginning of the CREX message

Section 1 – Data description section

Group No.	*Contents*	*Meanings*
1	Ttteevv	T: Indicator for CREX Tables
		tt: CREX Master table used (00 for WMO standard FM 95 CREX tables)
		ee: CREX edition number
		vv: CREX table version number

Section 1 – Data description section (*continued*)

Group No.	*Contents*	*Meanings*
2	Annn	A: Indicator for CREX Table A entry nnn: Data category from CREX Table A
3 to n	Bxxyyy, Cxxyyy, Dxxyyy and/or Rxxyyy:	B, C, D: Indicators for CREX Tables B,C,D entries; xxyyy, xxyyy, xxyyy: 5 digits each which indicates references from CREX Tables B, C and/or D R: Indicator for replication: xx=number of replicated descriptors, yyy=number of replications (delayed replication if yyy= 0)
(n + 1	E)	E: Optional check digit indicator

Section 2 – Data section

Group No.	*Contents*	*Meanings*
1 to m	(d)Data values	d: Optional check digit, data values corresponding to section 1 descriptors

(Section 3 – Optional section)

Group No.	*Contents*	*Meanings*
1	SUPP	The four letters SUPP indicate the presence of a supplementary optional section.
2 to p	To be developed by generating Centre	Additional items for local use

Section 4 – End section

Group No.	*Contents*	*Meanings*
1	7777	End of CREX

CREX TABLES, CODES TABLES, FLAG TABLES AND TEMPLATE EXAMPLES

FM 95 CREX refers to three types of tables: CREX tables, code tables and flag tables.

CREX tables

Tables containing information used to describe, classify and define the contents of a CREX message are called CREX tables. Four CREX tables are defined: Tables A, B, C and D. Entries numbering shall be the same in CREX Tables and BUFR tables for the same entity represented. CREX Tables D and BUFR Tables D shall be independant. However, if CREX common sequences are the same as BUFR Table D sequences, they are not defined in CREX Table D. CREX Table D sequences, which are not defined in BUFR Table D, shall be assigned a number not used by any BUFR sequences.

Code tables and flag tables

CREX Table B defines some elements by means of code tables or flag tables. Within this general description are included code tables referenced by code figures, and flag tables where each bit is set to 0 or 1 to indicate a false or true value with respect to a specific criterion. Within CREX all code tables and flag tables refer to elements defined within CREX Table B; they are numbered according to the xx and yyy values of the corresponding Table B reference.

Code tables in CREX

CREX Code tables have the same code figure as BUFR Code tables and are not reproduced. Values of the CREX code which are equal to or beyond the missing value of BUFR code figure shall not be used. Missing value in CREX for code table shall be indicated by a set of solidi "/" covering the data width.

Flag tables in CREX

CREX Flag Tables shall be the same as BUFR Flag Tables. However Flag Tables in CREX shall be expressed using octal representation in the following way: a set of three bits being represented by a figure from 0 to 7 (the leftmost bit being the first bit in the table rank), zeros being added on the left when the number of flags is not a multiple of 3:

000 = 0 (not bit set)
001 = 1 (bit 3 set)
010 = 2 (bit 2 set)
011 = 3 (bits 2 and 3 set)
100 = 4 (bit 1 set)
101 = 5 (bits 1 and 3 set)
110 = 6 (bits 1 and 2 set)
111 = 7 (all bits set).

For example, the seven flags table sequence "1100110" transformed with the addition on the left of two zeros to "001100110" would be translated to "146" in octal.

CREX Flag Tables which are the same as BUFR flag table are not reproduced here.

In CREX, missing value for flag table shall be indicated by a set of solidi "/" covering the data width.

CREX template examples

Examples of templates of some CREX messages are listed as models to help users understand the CREX code.

CREX TABLE RELATIVE TO SECTION 1

CREX Table A – *Data category*

Code figure	*Data type*
000	Surface data – land
001	Surface data – sea
002	Vertical soundings (other than satellite)
003	Vertical soundings (satellite)
004	Single level upper-air data (other than satellite)
005	Single level upper-air data (satellite)
006	Radar data
007	Synoptic features
008	Physical/chemical constituents
009	Dispersal and transport
010	Radiological data
011	CREX tables, complete replacement or update
012	Surface data (satellite)
013–019	Reserved
020	Status information
021	Radiances (satellite measured)
022–030	Reserved
031	Oceanographic data
032–100	Reserved
101	Image data
102–239	Reserved
240–254	For experimental use
255	Indicator for local use

CREX TABLES RELATIVE TO SECTION 2

(Additional elements relative to existing BUFR Tables are in italics)

CREX Table B – *Classification of elements*

B X	*Class*	*Comments*
B 00	CREX table entries	
B 01	Identification	Identifies origin and type of data
B 02	Instrumentation	Defines instrument types used
B 03	Reserved	

CREX **table B –** ***Classification of elements*** (*continued*)

B X	*Class*	*Comments*
B 04	Location (time)	Defines time and time derivatives
B 05	Location (horizontal-1)	Defines geographical position, including horizontal derivatives, in association with class 06 (first dimension of horizontal space)
B 06	Location (horizontal-2)	Defines geographical position including horizontal derivatives, in association with class 05 (second dimension of horizontal space)
B 07	Location (vertical)	Defines height, altitude, pressure level, including vertical derivatives of position
B 08	Significance qualifiers	Defines special character of data
B 09	Reserved	
B 10	Non-coordinate location (vertical)	Height, altitude, and derivatives observed or measured, not defined as a vertical location
B 11	Wind and turbulence	Wind speed, direction, etc.
B 12	Temperature	
B 13	Hydrographic and hydrological elements	Humidity, rainfall, snowfall. etc.
B 14	Radiation and radiance	
B 15	Physical/chemical constituents	
B 19	Synoptic features	
B 20	Observed phenomena	Defines present/past weather, special phenomena, etc.
B 21	Radar data	
B 22	Oceanographic elements	
B 23	Dispersal and transport	
B 24	Radiological elements	
B 25	Processing information	
B 26	Non-coordinate location (time)	Defines time and time derivatives that are not coordinates
B 27	Non-coordinate location (horizontal-1)	Defines geographical positions, in conjunction with class 28, that are not coordinates
B 28	Non-coordinate location (horizontal-2)	Defines geographical positions, in conjunction with class 27, that are not coordinates
B 29	Map data	
B 30	Image	
B 33	Quality information	
B 35	*Data monitoring information*	

NOTES:
(1) Where a code table or flag table is appropriate, 'code table' or 'flag table', respectively is entered in the UNITS column.
(2) The code tables and flag tables associated with Table B are numbered to correspond with the xx and yyy part of the table reference.
(3) To encode values into CREX, the data (with units as specified in the UNITS column) must be multiplied by 10 to the power SCALE.
(4) Where UNITS are given as character, data shall be coded as character data left justified within the field width.
(5) Classes 48 to 63 are reserved for local use; all other classes are reserved for future development.
(6) Entries 192 to 255 within all classes are reserved for local use.
(7) The use of local descriptors, as defined in Notes 5 and 6, in messages intended for non-local or international exchange is strongly discouraged.
(8) First-order statistics are included in Table B only when they are produced, as such, by the observing system.

Class 00 – CREX table entries

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 00 001	Table A: entry	Character	0	3
B 00 002	Table A: data category description, line 1	Character	0	32
B 00 003	Table A: data category description, line 2	Character	0	32
B 00 005	CREX edition number	Character	0	3
B 00 010	F descriptor to be added or defined	Character	0	1
B 00 011	X descriptor to be added or defined	Character	0	2
B 00 012	Y descriptor to be added or defined	Character	0	3
B 00 013	Element name, line 1	Character	0	32
B 00 014	Element name, line 2	Character	0	32
B 00 015	Units name	Character	0	24
B 00 016	Units scale sign	Character	0	1
B 00 017	Units scale	Character	0	3
B 00 018	Units reference sign	Character	0	1
B 00 019	Units reference value	Character	0	10
B 00 020	Element data width	Character	0	3
B 00 030	Descriptor defining sequence	Character	0	6

Class 01 – Identification

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 01 001	WMO block number	Numeric	0	2
B 01 002	WMO station number	Numeric	0	3
B 01 003	WMO Region number/geographical area	Code table	0	1
B 01 004	WMO Region sub-area (see note 1)	Numeric	0	1
B 01 005	Buoy/platform identifier	Numeric	0	5
B 01 006	Aircraft flight number	Character	0	8
B 01 007	Satellite identifier	Code table	0	4
B 01 008	Aircraft registration number	Character	0	8
B 01 009	Type of commercial aircraft	Character	0	8
B 01 010	Stationary buoy platform identifier; e.g. C-MAN buoys	Character	0	8
B 01 011	Ship or mobile land station identifier	Character	0	9
B 01 012	Direction of motion of moving observing platform	Degree true	0	3
B 01 013	Speed of motion of moving observing platform	$m\ s^{-1}$	0	3
B 01 014	Platform drift speed (high precision)	$m\ s^{-1}$	2	4
B 01 015	Station or site name	Character	0	20
B 01 018	*Short station or site name*	*Character*	*0*	*5*
B 01 020	WMO Region sub-area	Numeric	0	2
B 01 021	Synoptic feature identifier	Numeric	0	4
B 01 022	Name of feature (see note 2)	Character	0	28
B 01 025	Storm identifier (see note 3)	Character	0	3
B 01 026	WMO storm name (see note 4)	Character	0	8
B 01 031	Identification of originating/generating centre (see note 5)	Code table	0	5
B 01 032	Generating application	Code table	0	3
B 01 033	Identification of originating/generating centre	Code table	0	3
B 01 034	Identification of originating/generating sub-centre	Code table	0	3
B 01 041	Absolute platform velocity – first component	$m\ s^{-1}$	5	10
B 01 042	Absolute platform velocity – second component	$m\ s^{-1}$	5	10
B 01 043	Absolute platform velocity – third component	$m\ s^{-1}$	5	10
B 01 050	ARGOS platform transmitter ID number	Numeric	0	6
B 01 051	GOES platform transmitter ID number	Character	0	12
B 01 060	Aircraft reporting point (Beacon identifier)	Character	0	8
B 01 062	*Short ICAO location indicator*	*Character*	*0*	*4*
B 01 063	ICAO location indicator	Character	0	8
B 01 064	Runway designator	Character	0	4
B 01 075	Tide station identification	Character	0	5

NOTES:

(1) Descriptor B 01 020 should be used instead of B 01 004 (could be found in old archived BUFR data) for encoding this element.

(2) For B 01 022 the character string representing the "Name of feature" should be of the form: "Type of phenomenon" — "Location or geographical name" (e.g.: "volcano — Popocatepetl", "oil fire — Kuwait").

(3) The storm identifier (descriptor B 01 025) has the following meaning: the first two characters shall be a numeric sequence number assigned by the originator of the message; the third character is a letter indicating the ocean basin where the storm is located, as follows:

W NW Pacific Ocean

E NE Pacific Ocean to 140°W

C NE Pacific Ocean 140°W–180°W
L N Atlantic Ocean, including Caribbean and Gulf of Mexico
A N Arabian Sea
B Bay of Bengal
S S Indian Ocean
P S Pacific Ocean
U Australia
O South China Sea
T East China Sea

There is no requirement that differing observers coordinate sequence numbers even though they both may be reporting the same storm.

(4) WMO storm name (descriptor B 01 026): the storm name NAMELESS shall be used in those cases where an identifiable tropical disturbance has not reached tropical storm strength and has not been assigned an official name.

(5) Descriptor B 01 033 should be used instead of B 01 031 (could be found in old archived BUFR data) for encoding this element.

Class 02 – Instrumentation

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 02 001	Type of station	Code table	0	1
B 02 002	Type of instrumentation for wind measurement	Flag table	0	2
B 02 003	Type of measuring instrument used	Code table	0	2
B 02 004	Type of instrumentation for evaporation measurement or type of crop for which evapotranspiration is reported	Code table	0	2
B 02 005	Precision of temperature observation	K	2	3
B 02 011	Radiosonde type	Code table	0	3
B 02 012	Radiosonde computational method	Code table	0	2
B 02 013	Solar and infrared radiation correction	Code table	0	2
B 02 014	Tracking technique/status of system used	Code table	0	3
B 02 015	Radiosonde completeness	Code table	0	2
B 02 019	Satellite instrument	Common code table	0	4
B 02 020	Satellite classification	Code table	0	3
B 02 021	Satellite instrument data used in processing	Flag table	0	3
B 02 022	Satellite data processing technique used	Flag table	0	3
B 02 023	Satellite derived wind computation method	Code table	0	2
B 02 024	Integrated mean humidity computational method	Code table	0	2
B 02 025	Satellite channel(s) used in computation	Flag table	0	9
B 02 026	Cross track resolution	m	2	4
B 02 027	Along track resolution	m	2	4
B 02 028	Segment size at Nadir in x direction	m	0	6
B 02 029	Segment size at Nadir in y direction	m	0	6
B 02 030	Method of current measurement	Code table	0	1
B 02 031	Duration and time of current measurement	Code table	0	2
B 02 032	Indicator for digitization	Code table	0	1
B 02 033	Method of salinity/depth measurement	Code table	0	1
B 02 034	Drogue type	Code table	0	2
B 02 035	Cable length	m	0	3
B 02 036	Buoy type	Code table	0	1
B 02 037	Method of tidal observation	Code table	0	1
B 02 038	Method of sea-surface temperature measurement	Code table	0	2
B 02 039	Method of wet-bulb temperature measurement	Code table	0	1
B 02 040	Method of removing velocity and motion of platform from current	Code table	0	2
B 02 041	Method of estimating reports related to synoptic features	Code table	0	2
B 02 044	Indicator for method of calculating spectral wave data	Code table	0	2
B 02 045	Indicator for type of platform	Code table	0	2
B 02 046	Wave measurement instrumentation	Code table	0	2
B 02 048	Satellite sensor indicator	Code table	0	2
B 02 049	Geostationary satellite data-processing technique used	Flag table	0	3
B 02 050	Geostationary sounder satellite channels used	Flag table	0	7
B 02 051	Indicator to specify observing method for extreme temperatures	Code table	0	2
B 02 052	Geostationary imager satellite channels used	Flag table	0	2
B 02 055	Geostationary sounding statistical parameters	Code table	0	2
B 02 056	Geostationary sounding accuracy statistics	Code table	0	2
B 02 057	Origin of first guess information for GOES-I/M soundings	Code table	0	2
B 02 058	Valid times of first guess information for GOES-I/M soundings	Code table	0	2
B 02 059	Origin of analysis information for GOES-I/M soundings	Code table	0	2

Class 02 – Instrumentation (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 02 060	Origin of surface information for GOES-I/M soundings	Code table	0	2
B 02 061	Aircraft navigational system	Code table	0	1
B 02 062	Type of aircraft data relay system	Code table	0	2
B 02 063	Aircraft roll angle	Degree	2	5
B 02 064	Aircraft roll angle quality	Code table	0	1
B 02 065	ACARS ground receiving station	Character	0	5
B 02 070	Original specification of latitude/longitude	Code table	0	2
B 02 100	Radar constant (see note 4)	dB	1	4
B 02 101	Type of antenna	Code table	0	2
B 02 102	Antenna height above tower base	m	0	3
B 02 103	Radome	Flag table	0	1
B 02 104	Antenna polarization	Code table	0	2
B 02 105	Maximum antenna gain	dB	0	2
B 02 106	3-dB beamwidth	Degree	1	2
B 02 107	Sidelobe suppression	dB	0	2
B 02 108	Crosspol discrimination (on axis)	dB	0	2
B 02 109	Antenna speed (azimuth)	Degree s^{-1}	2	4
B 02 110	Antenna speed (elevation)	Degree s^{-1}	2	4
B 02 111	Radar incidence angle	Degree	1	4
B 02 112	Radar look angle	Degree	1	4
B 02 113	Number of azimuth looks	Numeric	0	2
B 02 114	Antenna effective surface area	m^2	0	5
B 02 121	Mean frequency	Hz	-8	3
B 02 122	Frequency agility range	Hz	-6	3
B 02 123	Peak power	W	-4	3
B 02 124	Average power	W	-1	3
B 02 125	Pulse repetition frequency	Hz	-1	3
B 02 126	Pulse width	s	7	2
B 02 127	Receiver intermediate frequency	Hz	-6	3
B 02 128	Intermediate frequency bandwidth	Hz	-5	2
B 02 129	Minimum detectable signal	dB	0	3
B 02 130	Dynamic range	dB	0	3
B 02 131	Sensitivity time control (STC)	Flag table	0	1
B 02 132	Azimuth pointing accuracy	Degree	2	2
B 02 133	Elevation pointing accuracy	Degree	2	2
B 02 134	Antenna beam azimuth	Degree	2	5
B 02 135	Antenna elevation	Degree	2	5
B 02 136	Range processed by range attenuation correction	m	-3	5
B 02 140	Satellite radar beam azimuth angle	Degree	0	3
B 02 141	Measurement type	Character	0	3
B 02 142	Ozone instrument serial number/identification (see note 5)	Character	0	4
B 02 143	Ozone instrument type	Code table	0	3
B 02 144	Light source type for Brewer spectrophotometer	Code table	0	2
B 02 145	Wave length setting for Dobson instruments	Code table	0	2
B 02 146	Source conditions for Dobson instruments	Code table	0	2
B 02 148	Location system	Code table	0	2
B 02 149	Type of data buoy	Code table	0	2
B 02 150	TOVS/ATOVS/AVHRR instrumentation channel number	Code table	0	2
B 02 151	Radiometer identifier	Code table	0	2
B 02 152	Satellite instrument used in data processing	Flag table	0	10
B 02 153	Satellite channel centre frequency	Hz	-8	8
B 02 154	Satellite channel band width	Hz	-8	8
B 02 163	Height assignment method	Code table	0	2
B 02 164	Trace correlation method	Code table	0	1
B 02 166	Radiance type	Code table	0	2
B 02 167	Radiance computational method	Code table	0	2

NOTES:

(1) This class shall contain elements to describe the instrumentation used to obtain meteorological elements reported.

(2) This class may also contain elements relating to observational procedures.

(3) Some indication of the expected accuracy may be implied in conjunction with certain elements in this class.

(4) This constant is defined as follows:

$$Z = P + \text{radar constant}$$

where: Z = reflectivity of target in beam direction (dBz)
P = the input receiver power above 1 mW (dBm)

This constant is used to normalize the signal to the equivalent 100 km range.

(5) Ozone instrument serial number identification is four characters long. For Japanese Dobsons instruments, omit leading digit(s).

Class 04 – Location (time)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 04 001	Year	Year	0	4
B 04 002	Month	Month	0	2
B 04 003	Day	Day	0	2
B 04 004	Hour	Hour	0	2
B 04 005	Minute	Minute	0	2
B 04 006	Second	Second	0	2
B 04 011	Time increment	Year	0	4
B 04 012	Time increment	Month	0	4
B 04 013	Time increment	Day	0	4
B 04 014	Time increment	Hour	0	4
B 04 015	Time increment	Minute	0	4
B 04 016	Time increment	Second	0	4
B 04 021	Time period or displacement	Year	0	4
B 04 022	Time period or displacement	Month	0	4
B 04 023	Time period or displacement	Day	0	4
B 04 024	Time period or displacement	Hour	0	4
B 04 025	Time period or displacement	Minute	0	4
B 04 026	Time period or displacement	Second	0	4
B 04 031	Duration of time relating to following value	Hour	0	3
B 04 032	Duration of time relating to following value	Minute	0	2
B 04 041	Time difference UTC-LMT (see note 6)	Minute	0	4
B 04 043	*Day of the year (starting from the first day of the year)*	Day	0	3
B 04 053	*Number of days with precipitation equal to or more than 1 mm*	*Numeric*	*0*	*2*
B 04 065	*Short time increment*	*Minute*	*0*	*2*
B 04 073	*Short time period or displacement*	*Day*	*0*	*2*
B 04 075	*Short time period or displacement*	*Minute*	*0*	*2*

NOTES:
(1) The significance of the time periods or displacements shall be indicated using the time significance code corresponding to CREX Code table B 08 021.
(2) Where more than one time period or displacement is required to define complex time structures they shall be defined in immediate succession, and the following order shall apply: ensemble period (if required), followed by forecast period (if required), followed by period for averaging or accumulation (if required).
(3) Time periods or displacements, and time increments, require an initial time location to be defined prior to their use, followed where appropriate by a time significance definition.
(4) The time location, when used with forecast values, shall indicate the time of the initial state for the forecast or the beginning of the forecast period; when used with ensemble means of forecast values, the time location shall indicate the initial state or the beginning of the first forecast over which ensemble means are derived.
(5) Negative time periods or displacements shall be used to indicate time periods or displacements preceding the currently defined time.
(6) Descriptor B 04 041 has been replaced by the combination of B 08 025 and B 26 003 and should not be used for encoding this element.
(7) All times are Universal Time Coordinated (UTC) unless otherwise noted.

Class 05 – Location (horizontal-1)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 05 001	Latitude (high accuracy)	Degree	5	7
B 05 002	Latitude (coarse accuracy)	Degree	2	4
B 05 011	Latitude increment (high accuracy)	Degree	5	7
B 05 012	Latitude increment (coarse accuracy)	Degree	2	4
B 05 021	Bearing or azimuth	Degree true	2	5
B 05 022	Solar azimuth	Degree true	2	5
B 05 030	Direction (spectral)	Degree	0	4
B 05 031	Row number	Numeric	0	4
B 05 033	Pixel size on horizontal-1	m	-1	5
B 05 040	Orbit number	Numeric	0	8
B 05 041	Scan line number	Numeric	0	3
B 05 042	Channel number	Numeric	0	2
B 05 043	Field of view number	Numeric	0	3
B 05 052	Channel number increment	Numeric	0	2
B 05 053	Field of view number increment	Numeric	0	2

NOTES:
(1) Values of latitude and latitude increments are limited to the range -90 degrees to +90 degrees.
(2) South latitude shall be assigned negative values.
(3) North to South increments shall be assigned negative values.
(4) Bearing or azimuth shall only be used with respect to a stated location, and shall not redefine that location.
(5) The pixel size on horizontal-1 is given at a location where the map scale factor is unity.

Class 06 – Location (horizontal-2)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 06 00l	Longitude (high accuracy)	Degree	5	8
B 06 002	Longitude (coarse accuracy)	Degree	2	5
B 06 011	Longitude increment (high accuracy)	Degree	5	8
B 06 012	Longitude increment (coarse accuracy)	Degree	2	5
B 06 021	Distance	m	-1	4
B 06 030	Wave number (spectral)	rad m^{-1}	5	4
B 06 031	Column number	Numeric	0	4
B 06 033	Pixel size on horizontal-2	m	-1	5
B 06 040	Radius of confidence	m	0	4

NOTES:
(1) Values of longitude are limited to the range –180 degrees to +180 degrees.
(2) West longitude shall be assigned negative values.
(3) East to West increments shall be assigned negative values.
(4) Distance shall only be used with respect to a stated location and a bearing, azimuth or elevation; it shall not define that location.
(5) The pixel size on horizontal-2 is given at a location where map scale factor is unity.

Class 07 – Location (vertical)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 07 001	Height of station	m	0	5
B 07 002	Height or altitude	m	-1	5
B 07 003	Geopotential	$m^2\ s^{-2}$	-1	6
B 07 004	Pressure	Pa	-1	5
B 07 005	Height increment	m	0	4
B 07 006	Height above station	m	0	5
B 07 007	Height	m	0	6
B 07 008	Geopotential	$m^2\ s^{-2}$	0	7
B 07 021	Elevation	Degree	2	5
B 07 022	Solar elevation	Degree	2	5
B 07 024	Satellite zenith angle	Degree	2	5
B 07 025	Solar zenith angle	Degree	2	5
B 07 061	Depth below land surface	m	2	5
B 07 062	Depth below sea/water surface	m	1	6
B 07 070	Drogue depth	m	0	4

NOTE: Elevation shall only be used with respect to a stated location and a bearing, azimuth, or distance; it shall not redefine that location.

Class 08 – Significance qualifiers

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 08 001	Vertical sounding significance	Flag table	0	3
B 08 002	Vertical significance (surface observations)	Code table	0	2
B 08 003	Vertical significance (satellite observations)	Code table	0	2
B 08 004	Phase of aircraft flight	Code table	0	1
B 08 005	Meteorological attribute significance	Code table	0	2
B 08 006	*Ozone vertical sounding significance*	*Flag table*	*0*	*3*
B 08 007	Dimensional significance	Code table	0	2
B 08 011	Meteorological feature	Code table	0	2
B 08 012	Land/sea qualifier	Code table	0	1
B 08 013	Day/night qualifier	Code table	0	1
B 08 014	Qualifier for runway visual range	Code table	0	2
B 08 016	Change qualifier of a trend-type forecast or an aerodrome forecast	Code table	0	1
B 08 017	Qualifier of the time when the forecast change is expected	Code table	0	1
B 08 020	Total number of missing entities (with respect to accumulation or average)	Numeric	0	5
B 08 021	Time significance	Code table	0	2
B 08 022	Total number (with respect to accumulation or average)	Numeric	0	5
B 08 023	First-order statistics	Code table	0	2
B 08 024	Difference statistics	Code table	0	2
B 08 025	Time difference qualifier	Code table	0	2
B 08 030	*Manual on Codes* (Volume I.1, Section C) Code table from which data are derived	Numeric	0	4

Class 08 – Significance qualifiers (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 08 031	*Data category – CREX table A*	*Numeric*	*0*	*3*
B 08 035	*Type of monitoring exercise*	*Code table*	*0*	*1*
B 08 036	*Type of centre or station performing monitoring*	*Code table*	*0*	*1*
B 08 051	Qualifier for number of missing values in calculation of statistic	Code table	0	1
B 08 052	Condition for which number of days of occurrence follows	Code table	0	2
B 08 053	Day of occurrence qualifier	Code table	0	1
B 08 060	Sample scanning mode significance	Code table	0	2
B 08 070	TOVS/ATOVS product qualifier	Code table	0	2
B 08 072	Pixel(s) type	Code table	0	1

NOTES:
(1) Where values are accumulated or averaged (for example over a time period) the total number of values from which the accumulated or averaged values are obtained may be represented using reference B 08 022.
(2) A previously defined significance may be cancelled by transmitting a "missing" from the appropriate code or flag table.
(3) Descriptor B 08 025 is to be used with B 26 003 (time difference).

Class 10 – Non-coordinate location (vertical)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 10 001	Height of land surface	m	0	5
B 10 002	Height	m	-1	5
B 10 003	Geopotential	$m^2 s^{-2}$	-1	6
B 10 004	Pressure	Pa	-1	5
B 10 007	Height	m	0	6
B 10 008	Geopotential	$m^2 s^{-2}$	0	7
B 10 031	In direction of the North Pole, distance from the Earth's centre	m	2	10
B 10 050	Standard deviation altitude	m	2	5
B 10 051	Pressure reduced to mean sea level	Pa	-1	5
B 10 052	Altimeter setting (QNH)	Pa	-1	5
B 10 060	Pressure change	Pa	-1	4
B 10 061	3-hour pressure change	Pa	-1	4
B 10 062	24-hour pressure change	Pa	-1	4
B 10 063	Characteristic of pressure tendency	Code table	0	2
B 10 070	Indicated aircraft altitude	m	0	5

NOTE: Vertical elements and pressure shall be used to define values of these elements independent of the element or variable denoting the vertical coordinate.

Class 11 – Wind and turbulence

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 11 001	Wind direction	Degree true	0	3
B 11 002	Wind speed	$m s^{-1}$	1	4
B 11 003	u-component	$m s^{-1}$	1	4
B 11 004	v-component	$m s^{-1}$	1	4
B 11 005	w-component	$Pa s^{-1}$	1	4
B 11 006	w-component	$m s^{-1}$	2	4
B 11 011	Wind direction at 10 m	Degree true	0	3
B 11 012	Wind speed at 10 m	$m s^{-1}$	1	4
B 11 013	Wind direction at 5 m	Degree true	0	3
B 11 014	Wind speed at 5 m	$m s^{-1}$	1	4
B 11 016	Extreme counterclockwise wind direction of a variable wind	Degree true	0	3
B 11 017	Extreme clockwise wind direction of a variable wind	Degree true	0	3
B 11 019	Steadiness of wind	%	0	3
B 11 021	Relative vorticity	s^{-1}	9	6
B 11 022	Divergence	s^{-1}	9	6
B 11 023	Velocity potential	$m^2 s^{-1}$	-2	6
B 11 031	Degree of turbulence	Code table	0	2
B 11 032	Height of base of turbulence	m	-1	5
B 11 033	Height of top of turbulence	m	-1	5
B 11 034	Vertical gust velocity	$m s^{-1}$	1	4

Class 11 – Wind and turbulence (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 11 035	Vertical gust acceleration	m s^{-2}	2	5
B 11 036	Maximum derived equivalent vertical gust speed	m s^{-1}	1	4
B 11 040	*Maximum wind speed (mean wind)*	*m s^{-1}*	*1*	*4*
B 11 041	Maximum wind speed (gusts)	m s^{-1}	1	4
B 11 042	Maximum wind speed (10 minute mean wind)	m s^{-1}	1	4
B 11 043	Maximum wind gust direction	Degree true	0	3
B 11 044	Mean wind direction for surface –1 500 m (5 000 ft)	Degree true	0	3
B 11 045	Mean wind speed for surface –1 500 m (5 000 ft)	m s^{-1}	1	4
B 11 049	Standard deviation of wind direction	Degree true	0	3
B 11 050	Standard deviation of horizontal wind speed	m s^{-1}	1	4
B 11 051	Standard deviation of vertical wind speed	m s^{-1}	1	3
B 11 061	Absolute wind shear in 1 km layer below	m s^{-1}	1	4
B 11 062	Absolute wind shear in 1 km layer above	m s^{-1}	1	4
B 11 070	Designator of the runway affected by wind shear (including ALL)	Character	0	4
B 11 071	Turbulent vertical momentum flux	m^2 s^{-2}	3	5
B 11 072	Turbulent vertical buoyancy flux	K m s^{-1}	3	4
B 11 073	Turbulent kinetic energy	m^2 s^{-2}	2	4
B 11 074	Dissipation energy	m^2 s^{-2}	2	4
B 11 075	Mean turbulence intensity (eddy dissipation rate)	$m^{2/3}$ s^{-1}	2	3
B 11 076	Peak turbulence intensity (eddy dissipation rate)	$m^{2/3}$ s^{-1}	2	3

NOTES:

(1) West to east u-components shall be assigned positive values.

(2) South to north v-components shall be assigned positive values.

(3) Upward w-components shall be assigned positive values where units are m s^{-1}.

(4) Downward w-components shall be assigned positive values where units are Pa s^{-1}.

(5) Wind reporting standards:

Observation	*Speed*	*Direction*
No observation	Missing	Missing
Calm	0	0
Normal observation	>0	1°–360°
Speed only	>0	Missing
Direction only	Missing	1°–360°
"Light and variable"	>0	0

(6) Element 0 11 019:
The steadiness factor is the ratio of speed of the monthly mean vector wind to the speed of the monthly mean scalar wind expressed as a percentage. It is reported to the nearest one per cent.

Class 12 – Temperature

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 12 001	Temperature/dry-bulb temperature	°C	1	3
B 12 002	Wet-bulb temperature	°C	1	3
B 12 003	Dew-point temperature	°C	1	3
B 12 004	Dry-bulb temperature at 2 m	°C	1	3
B 12 005	Wet-bulb temperature at 2 m	°C	1	3
B 12 006	Dew-point temperature at 2 m	°C	1	3
B 12 007	Virtual temperature	°C	1	3
B 12 011	Maximum temperature, at height and over period specified	°C	1	3
B 12 012	Minimum temperature, at height and over period specified	°C	1	3
B 12 013	Ground minimum temperature, past 12 hours	°C	1	3
B 12 014	Maximum temperature at 2 m, past 12 hours	°C	1	3
B 12 015	Minimum temperature at 2 m, past 12 hours	°C	1	3
B 12 016	Maximum temperature at 2 m, past 24 hours	°C	1	3
B 12 017	Minimum temperature at 2 m, past 24 hours	°C	1	3
B 12 030	Soil temperature	°C	1	3
B 12 031	*Soil temperature at 50 cm below the ground*	*K*	*1*	*4*
B 12 051	Standard deviation temperature	°C	1	3
B 12 052	Highest daily mean temperature	°C	1	3
B 12 053	Lowest daily mean temperature	°C	1	3

Class 12 – Temperature (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 12 061	Skin temperature	°C	1	3
B 12 062	Equivalent black body temperature	°C	1	3
B 12 063	Brightness temperature	°C	1	3
B 12 064	Instrument temperature	K	1	4
B 12 071	Coldest cluster temperature	K	1	4
B 12 072	Radiance	W m^{-2} sr m^{-1}	6	9

NOTE: Where the expression 'at height and over period specified' is entered under ELEMENT NAME, an appropriate vertical location shall be specified using descriptors from Class 07 together with an appropriate period using descriptors from Class 04.

Class 13 – Hydrographic and hydrological elements

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 13 001	Specific humidity	kg kg^{-1}	5	5
B 13 002	Mixing ratio	kg kg^{-1}	5	5
B 13 003	Relative humidity	%	0	3
B 13 004	Vapour pressure	Pa	-1	4
B 13 005	Vapour density	kg m^{-3}	3	3
B 13 006	Mixing heights	m	-1	5
B 13 008	Total precipitation/total water equivalent	kg m^{-2}	1	5
B 13 009	Depth of fresh snow	m	2	4
B 13 010	Total snow depth	m	2	5
B 13 014	Rainfall/water equivalent of snow (averaged rate)	kg m^{-2} s^{-1}	4	4
B 13 015	Snowfall (averaged rate)	m s^{-1}	7	4
B 13 016	Precipitable water	kg m^{-2}	0	3
B 13 019	*Precipitation last hour*	*kg m^{-2}*	*0*	*4*
B 13 024	Total precipitation past 1 hour	kg m^{-2}	1	5
B 13 025	Total precipitation past 3 hours	kg m^{-2}	1	5
B 13 026	Total precipitation past 6 hours	kg m^{-2}	1	5
B 13 027	Total precipitation past 12 hours	kg m^{-2}	1	5
B 13 028	Total precipitation past 24 hours	kg m^{-2}	1	5
B 13 031	Evapotranspiration	kg m^{-2}	0	3
B 13 032	Evaporation/evapotranspiration (see note 6)	kg m^{-2}	1	3
B 13 033	Evaporation/evapotranspiration	kg m^{-2}	1	4
B 13 038	Superadiabatic indicator	Code table	0	1
B 13 039	Terrain type (ice/snow)	Code table	0	1
B 13 041	Pasquill-Gifford stability category	Code table	0	2
B 13 042	Parcel lifted index (to 500 hPa)	K	0	2
B 13 043	Best lifted index (to 500 hPa)	K	0	2
B 13 051	Frequency group, precipitation	Code table	0	2
B 13 053	Highest daily amount of precipitation	kg m^{-2}	1	5
B 13 060	*Total accumulated precipitation*	*kg m^{-2}*	*1*	*5*
B 13 071	*Upstream water level*	*m*	*2*	*4*
B 13 072	*Downstream water level*	*m*	*2*	*4*
B 13 073	*Maximum water level*	*m*	*2*	*4*
B 13 080	*Water pH*	*pH unit*	*1*	*3*
B 13 081	*Water conductivity*	*Siemens m^{-1}*	*3*	*4*
B 13 082	*Water temperature*	*K*	*1*	*4*
B 13 083	*Dissolved oxygen*	*kg m^{-3}*	*6*	*4*
B 13 084	*Turbidity*	*Lumen*	*0*	*4*

NOTES:

(1) A total precipitation value of -1 shall indicate a 'trace'.

(2) A depth of fresh snow value of -1 shall indicate a depth of fresh snow less than 0.5 cm. A depth of fresh snow value of -2 shall indicate 'snow cover not continuous'.

(3) A total snow depth value of -1 shall indicate a total snow depth less than 0.5 cm. A total snow depth value of -2 shall indicate 'snow cover not continuous'.

(4) The "Parcel lifted index" (as defined in the *International Meteorological Vocabulary* (WMO-No. 182) under the listing "lifted index") is defined as the temperature difference between the ambient 500 hPa temperature (T500) and that of a parcel of air lifted from the surface (Tparcel) following the dry and moist adiabatic process. Negative values of (T500 – Tparcel) suggest instability. The "Best lifted index" is defined as the most unstable of a collection of parcel lifted indices, with parcel initial conditions defined for a collection of 30 hPa thick layers stacked one upon the other with the lowest resting on the ground. Commonly four to six such layers are used in the calculation.

(5) Since the two lifted indices (042 and 043) are defined as temperature differences they may take on negative values, even though the units are Kelvins.

(6) Descriptor B 13 033 should be used instead of descriptor B 13 032 to encode evaporation/evapotranspiration.

(7) Descriptors B 13 011, B 13 012, B 13 013, B 13 019, B 13 020, B 13 021, B 13 022, B 13 023, B 13 052 which can be found in old BUFR archives, should not be used and replaced respectively by B 13 008, B 13 009, B 13 010, B 13 024, B 13 025, B 13 026, B 13 027, B 13 028 and B 13 053.

Class 14 – Radiation and radiance

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 14 001	Long-wave radiation, integrated over 24 hours	J m^{-2}	-3	4
B 14 002	Long-wave radiation, integrated over period specified	J m^{-2}	-3	4
B 14 003	Short-wave radiation, integrated over 24 hours	J m^{-2}	-3	4
B 14 004	Short-wave radiation, integrated over period specified	J m^{-2}	-3	4
B 14 011	Net long-wave radiation, integrated over 24 hours	J m^{-2}	-3	4
B 14 012	Net long-wave radiation, integrated over period specified	J m^{-2}	-3	4
B 14 013	Net short-wave radiation, integrated over 24 hours	J m^{-2}	-3	4
B 14 014	Net short-wave radiation, integrated over period specified	J m^{-2}	-3	4
B 14 015	Net radiation, integrated over 24 hours	J m^{-2}	-4	5
B 14 016	Net radiation, integrated over period specified	J m^{-2}	-4	5
B 14 017	Instantaneous long-wave radiation	W m^{-2}	-3	4
B 14 018	Instantaneous sort-wave radiation	W m^{-2}	-3	4
B 14 019	Surface albedo	%	0	3
B 14 020	Global solar radiation, integrated over 24 hours	J m^{-2}	-4	5
B 14 021	Global radiation, integrated over period specified	J m^{-2}	-4	5
B 14 022	Diffuse solar radiation, integrated over 24 hours	J m^{-2}	-4	5
B 14 023	Diffuse solar radiation, integrated over period specified	J m^{-2}	-4	5
B 14 024	Direct solar radiation, integrated over 24 hours	J m^{-2}	-4	5
B 14 025	Direct solar radiation, integrated over period specified	J m^{-2}	-4	5
B 14 026	Albedo at the top of clouds	%	0	3
B 14 027	Albedo	%	0	3
B 14 031	Total sunshine	Minute	0	4
B 14 032	Total sunshine	Hour	0	4
B 14 033	Total sunshine	%	0	3
B 14 042	Bidirectional reflectance	%	0	3
B 14 045	Chanel radiance	W m^{-2} sr^{-1} cm^{-1}	0	4
B 14 051	*Direct solar radiation integrated over last hour*	*J m^{-2}*	*-3*	*4*

NOTES:
(1) Downward radiation shall be assigned negative values.
(2) Upward radiation shall be assigned positive values.
(3) Where the expression "period specified" is entered under ELEMENT NAME, an appropriate period shall be specified using descriptors from Class 04.

Class 15 – Physical/chemical constituents

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 15 001	Ozone	DU	0	4
B 15 002	Air mass (slant path at 22 km)	Numeric	2	3
B 15 003	*Measured ozone partial pressure (sounding)*	*nbar*	*0*	*3*
B 15 004	*Ozone sounding correction factor (CF)*	*Numeric*	*3*	*4*
B 15 005	*Ozone p*	*DU*	*0*	*3*
B 15 011	Log 10 of integrated electron density	log (m^{-2})	3	4
B 15 015	Maximum image spectral component before normalization	Numeric	0	10

NOTES:
(1) B 15 003 is partial pressure of ozone, measured at the pressure level identified by B 07 004.
(2) B 15 004 (CF) is defined as:
CF = TOI/TOS
where TOI is the integrated ozone value obtained "simultaneously to a sounding" from a Dobson or Brewer spectrophotometer at the site or "nearby" and TOS is the total ozone obtained from the sounding. TOS is the sum of the integrated ozone below the lowest pressure level reached by the sounding and the estimate of the amount above. In the absence of any spectrophotometer measurement, CF = ////.
(3) B 15 005 is the value obtained as the result of the vertical integration of the sounding values (B 15 003) measured below the lowest pressure level reached by the sonde, multiplied by B 15 004.
(4) DU = Dobson Unit.

Class 19 – Synoptic features

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 19 001	Type of synoptic feature	Code table	0	2
B 19 002	Effective radius of feature	m	-2	4
B 19 003	Wind speed threshold	m s^{-1}	0	3
B 19 004	Effective radius with respect to wind speeds above threshold	m	-2	4
B 19 005	Direction of motion of feature	Degree true	0	3
B 19 006	Speed of motion of feature	m s^{-1}	2	5
B 19 007	Effective radius of feature	m	-3	4
B 19 008	Vertical extent of circulation	Code table	0	1
B 19 009	Effective radius with respect to wind speeds above threshold (large storms)	M	-3	4
B 19 010	*Method for tracing of the centre of synoptic feature*	*Code table*	*0*	*2*

NOTES:
(1) The effective radius of feature shall be defined with respect to the radius of the 1 000 hPa isobar at mean sea level.
(2) Maximum wind and effective radius of maximum wind shall be indicated by means of the B 19 003 and B 19 004 entries.

Class 20 – Observed phenomena

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 20 001	Horizontal visibility	m	-1	4
B 20 002	Vertical visibility	m	-1	3
B 20 003	Present weather	Code table	0	3
B 20 004	Past weather (1)	Code table	0	2
B 20 005	Past weather (2)	Code table	0	2
B 20 008	Cloud distribution for aviation	Code table	0	2
B 20 009	General weather indicator (TAF/METAR)	Code table	0	2
B 20 010	Cloud cover (total)	%	0	3
B 20 011	Cloud amount	Code table	0	2
B 20 012	Cloud type	Code table	0	2
B 20 013	Height of base of cloud	m	-1	4
B 20 014	Height of top of cloud	m	-1	4
B 20 015	Pressure at base of cloud	Pa	-1	5
B 20 016	Pressure at top of cloud	Pa	-1	5
B 20 017	Cloud top description	Code table	0	2
B 20 018	Tendency of runway visual range	Code table	0	1
B 20 019	Significant present or forecast weather	Character	0	9
B 20 020	Significant recent weather phenomena	Character	0	4
B 20 031	Ice deposit (thickness)	m	2	3
B 20 032	Rate of ice accretion	Code table	0	1
B 20 033	Cause of ice accretion	Flag table	0	2
B 20 034	Sea ice concentration	Code table	0	2
B 20 035	Amount and type of ice	Code table	0	2
B 20 036	Ice situation	Code table	0	2
B 20 037	Ice development	Code table	0	2
B 20 038	Bearing of ice edge	Degree true	0	3
B 20 039	Ice distance	m	-1	4
B 20 041	Airframe icing	Code table	0	2
B 20 051	Amount of low clouds	%	0	3
B 20 052	Amount of middle clouds	%	0	3
B 20 053	Amount of high clouds	%	0	3
B 20 061	Runway visual range (RVR)	m	0	4
B 20 062	State of the ground (with or without snow)	Code table	0	2
B 20 063	Special phenomena	Code table	0	4
B 20 070	Minimum number of atmospherics	Numeric	0	3
B 20 071	Accuracy and rate of atmospherics	Code table	0	2
B 20 081	Cloud amount in segment	%	0	3
B 20 082	Amount segment cloud free	%	0	3
B 20 090	Special clouds	Code table	0	2

Class 21 – Radar data

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 21 001	Horizontal reflectivity	dB	0	3
B 21 002	Vertical reflectivity	dB	0	3
B 21 003	Differential reflectivity	dB	1	3
B 21 005	Linear depolarization ratio	dB	0	2
B 21 006	Circular depolarization ratio	dB	0	2
B 21 011	Doppler mean velocity in X-direction	m s^{-1}	0	3
B 21 012	Doppler mean velocity in Y-direction	m s^{-1}	0	3
B 21 013	Doppler mean velocity in Z-direction	m s^{-1}	0	3
B 21 014	Doppler mean velocity (radial)	m s^{-1}	1	4
B 21 017	Doppler velocity spectral width	m s^{-1}	1	3
B 21 021	Echo tops	m	-3	2
B 21 030	Signal to noise ratio	dB	0	3
B 21 031	Vertical integrated liquid water content	kg m^{-2}	0	3
B 21 036	Radar rainfall intensity	m s^{-1}	7	4
B 21 041	Bright-band height	m	-2	3
B 21 051	Signal power above 1 mW	dB	0	3
B 21 062	Backscatter	dB	2	4
B 21 063	Radiometric resolution (noise value)	%	1	4
B 21 064	Clutter noise estimate	Numeric	0	3
B 21 065	Missing packet counter	Numeric	0	3
B 21 066	Wave scatterometer product confidence	Flag table	0	4
B 21 067	Wind product confidence data	Flag table	0	5
B 21 068	Radar altimeter product confidence data	Flag table	0	3
B 21 069	SST product confidence data	Flag table	0	4
B 21 071	Peakiness	Numeric	0	5
B 21 072	Satellite altimeter calibration status	Flag table	0	2
B 21 073	Satellite altimeter instrument mode	Flag table	0	3
B 21 075	Image spectrum intensity	Numeric	0	3
B 21 076	Representation of intensities	Code table	0	1
B 21 077	Altitude correction (ionosphere)	m	3	5
B 21 078	Altitude correction (dry troposphere)	m	3	3
B 21 079	Altitude correction (wet troposphere)	m	3	4
B 21 080	Altitude correction (calibration constant)	m	3	4
B 21 081	Open loop correction (height-time loop)	m	3	4
B 21 082	Open loop correction (auto gain control)	dB	3	5
B 21 085	ATSR sea surface temperature across-track band number	Numeric	0	2

Class 22 – Oceanographic

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 22 001	Direction of waves	Degree true	0	3
B 22 002	Direction of wind waves	Degree true	0	3
B 22 003	Direction of swell waves	Degree true	0	3
B 22 004	Direction of current	Degree true	0	3
B 22 011	Period of waves	s	0	2
B 22 012	Period of wind waves	s	0	2
B 22 013	Period of swell waves	s	0	2
B 22 021	Height of waves	m	1	4
B 22 022	Height of wind waves	m	1	4
B 22 023	Height of swell waves	m	1	4
B 22 025	Standard deviation wave height	m	2	4
B 22 026	Standard deviation of significant wave height	m	2	4
B 22 031	Speed of current	m s^{-1}	2	4
B 22 035	*Tidal elevation with respect to local chart datum*	*m*	*2*	*4*
B 22 036	*Meteorological residual tidal elevation (surge or offset)*	*m*	*2*	*4*
B 22 037	Tidal elevation with respect to national land datum	m	3	5
B 22 038	Tidal elevation with respect to local chart datum	m	3	5
B 22 039	Meteorological residual tidal elevation (surge or offset)	m	3	4
B 22 040	Meteorological residual tidal elevation (surge or offset)	m	3	5
B 22 041	Sea-surface temperature (15-day running mean)	K	1	4
B 22 042	Sea/water temperature	K	1	4
B 22 043	Sea/water temperature	K	2	5
B 22 044	Sound velocity	m s^{-1}	1	5
B 22 050	Standard deviation sea-surface temperature	K	2	3

Class 22 – Oceanographic (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 22 061	State of the sea	Code table	0	2
B 22 062	Salinity	PPT	2	5
B 22 063	Total water depth	m	0	5
B 22 067	Instrument type for water temperature profile measurement	Code table	0	4
B 22 068	Water temperature profile recorder types	Code table	0	3
B 22 070	Significant wave height	m	2	4
B 22 071	Spectral peak wave period	s	1	3
B 22 072	Spectral peak wave length	m	0	4
B 22 073	Maximum wave height	m	2	4
B 22 074	Average wave period	s	1	3
B 22 075	Average wave length	m	0	4
B 22 076	Direction from which dominant waves are coming	Degree true	0	3
B 22 077	Directional spread of dominant wave	Degree	0	3
B 22 078	Duration of wave record	s	0	4
B 22 079	Length of wave record	m	0	5
B 22 080	Waveband central frequency	Hz	3	4
B 22 081	Waveband central wave number	m^{-1}	5	4
B 22 082	Maximum non-directional spectral wave density	m^2 s	2	7
B 22 083	Maximum non-directional spectral wave number	m^3	2	7
B 22 084	Band containing maximum non-directional spectral wave density	Numeric	0	3
B 22 085	Spectral wave density ratio	Numeric	0	3
B 22 086	Mean direction from which waves are coming	Degree true	0	3
B 22 087	Principal direction from which waves are coming	Degree true	0	3
B 22 088	First normalized polar coordinate from Fourier coefficients	Numeric	2	3
B 22 089	Second normalized polar coordinate from Fourier coefficients	Numeric	2	3
B 22 090	Non-directional spectral estimate by wave frequency	m^2 s	2	7
B 22 091	Non-directional spectral estimate by wave number	m^3	2	7
B 22 092	Directional spectral estimate by wave frequency	m^2 rad^{-1} s	2	7
B 22 093	Directional spectral estimate by wave number	m^4	2	7
B 22 094	Total number of wave bands	Numeric	0	3
B 22 095	Directional spread of individual waves	Degree	0	3
B 22 096	Spectral band width	s^{-1}	3	2
B 22 097	Mean wavelength > 731 m of image spectrum at low wave numbers	m	0	5
B 22 098	Wavelength spread (wavelength > 731 m) at low wave numbers	m	0	5
B 22 099	Mean direction at low wave numbers (wavelength > 731 m)	Degree true	0	3
B 22 100	Direction spread at low wave numbers (wavelength > 731 m)	Degree	0	3
B 22 101	Total energy (wavelength > 731 m) at low wave numbers	Numeric	0	10
B 22 120	Tide station automated water level check	Code table	0	2
B 22 121	Tide station manual water level check	Code table	0	2
B 22 122	Tide station automated meteorological data check	Code table	0	2
B 22 123	Tide station manual meteorological data check	Code table	0	2

NOTES:

(1) The significant wave height is defined as four times the square root of the energy spectrum integrated over direction and frequency. It corresponds to about the height that one-third of all waves exceed.

(2) The dominant wave is the one that has the maximum energy in the energy spectrum.

(3) Mean wave direction is the angle alpha1, and principal wave direction is angle alpha2, in the expression S(f,alpha) approximately equals:

$$c_{11} ¥ (0.5 + r_1 ¥ \cos(\text{alpha-alpha1}) + r_2 ¥ \cos(2(\text{alpha-alpha2}))) / \text{pi}$$

in which S(f,alpha) is the wave directional spectrum and c_{11} is the nondirectional spectrum, and the right hand side of this expression is the first two terms of the Fourier series expansion of S(f,alpha). If the mean and principal directions differ significantly (e.g, more than 15 degrees) for a given frequency, crossing seas are indicated.

(4) Descriptor 0 22 040 should be used instead of 0 22 039 for meteorological residual tidal elevation (surge or offset).

(5) Additional information:

0 22 097 nominal input range 0–10 000
0 22 098 nominal input range 0–10 000
0 22 099 nominal input range 0–359
0 22 100 nominal input range 0–359
0 22 101 nominal input range 0–2¥10^6, but may be greater because of uncertainty.

(6) Descriptors 001, 002, 003; the direction given in these entries is the direction waves are coming from.

(7) Descriptor 004; the direction given in this entry is thedirection towards which current is flowing.
(8) Wind waves and waves reporting standards:

Observation:	*Speed:*	*Direction:*
No observation	missing	missing
Calm	0	0
Normal observation	>0	1–360
Speed only	>0	missing
Direction only	missing	1–360
"light and variable"	>0	0

Class 23 – Dispersal and transport

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 23 001	Accident early notification — article applicable	Code table	0	1
B 23 002	Activity or facility involved in incident	Code table	0	2
B 23 003	Type of release	Code table	0	1
B 23 004	Countermeasures taken near border	Code table	0	1
B 23 005	Cause of incident	Code table	0	1
B 23 006	Incident situation	Code table	0	1
B 23 007	Characteristics of release	Code table	0	1
B 23 008	State of current release	Code table	0	1
B 23 009	State of expected release	Code table	0	1
B 23 016	Possibility of significant chemical toxic health effect	Code table	0	1
B 23 017	Flow discharge of major recipient	$m^3\ s^{-1}$	6	7
B 23 018	Release behaviour over time	Code table	0	1
B 23 019	Actual release height	m	0	6
B 23 021	Effective release height	m	0	6
B 23 022	Distance of release point or site of incident	m	0	8
B 23 023	Main transport speed in *the* atmosphere	$m\ s^{-1}$	1	4
B 23 024	Main transport speed in water	$m\ s^{-1}$	2	4
B 23 025	Main transport speed in ground water	$m\ s^{-1}$	2	4
B 23 027	Main transport direction in *the* atmosphere	Degree true	0	3
B 23 028	Main transport direction in water	Degree true	0	3
B 23 029	Main transport direction in ground water	Degree true	0	3
B 23 031	Possibility that plume will encounter precipitation in State in which incident occurred	Code table	0	1
B 23 032	Plume will encounter change in wind direction and/or speed flag	Code table	0	1

Class 24 – Radiological elements

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 24 001	Estimate of amount of radioactivity released up to specified time	Bq*	-11	9
B 24 002	Estimated maximum potential release	Bq	-11	9
B 24 003	Composition of release	Code table	0	2
B 24 004	Element name	Character	0	2
B 24 005	Isotope mass	Numeric	0	3
B 24 011	Dose	mSv*/**	2	10
B 24 012	Trajectory dose (defined location and expected time of arrival)	mSv	2	10
B 24 013	Gamma dose in air along the main transport path (defined location and time period)	mSv	2	10
B 24 021	Air concentration (of named isotope type including gross beta)	$Bq\ m^{-3}$	2	10
B 24 022	Concentration in precipitation (of named isotope type)	$Bq\ l^{-1}$	2	10

NOTE: Useful ranges used above:
10^{11}Bq to 10^{19} Bq for releases;
10^{-2}Bq to 10^{7} and 10^{-2} to 10^{7} for concentration and doses

*	*New named unit and symbol*	*In other SI units*	*Old special unit and symbol*	*Relationship old to new units*
	becquerel (Bq)	s^{-1}	curie (Ci)	1 Ci=3.7*10^{10}Bq
	sievert (Sv)	$J\ kg^{-1}$	rem (rem)	1 rem = 0.01 Sv

** Millisievert

Class 25 – Processing information

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 25 001	Range-gate length	m	-1	2
B 25 002	Number of gates averaged	Numeric	0	2
B 25 003	Number of integrated pulses	Numeric	0	3
B 25 004	Echo processing	Code table	0	1
B 25 005	Echo integration	Code table	0	1
B 25 006	Z to R conversion	Code table	0	1
B 25 007	Z to R conversion factor	Numeric	0	4
B 25 008	Z to R conversion exponent	Numeric	2	3
B 25 009	Calibration method	Flag table	0	2
B 25 010	Clutter treatment	Code table	0	2
B 25 011	Ground occultation correction (screening)	Code table	0	1
B 25 012	Range attenuation correction	Code table	0	1
B 25 013	Bright-band correction	Flag table	0	1
B 25 014	Azimuth clutter cut-off (see note 1)	Numeric	0	4
B 25 015	Radome attenuation correction	Flag table	0	1
B 25 016	Clear-air attenuation correction	dB m^{-1}	5	2
B 25 017	Precipitation attenuation correction	Flag table	0	1
B 25 018	A to Z law for attenuation factor	Numeric	7	2
B 25 019	A to Z law for attenuation exponent	Numeric	2	3
B 25 020	Mean speed estimation	Code table	0	1
B 25 021	Wind computation enhancement	Flag table	0	3
B 25 030	Running mean sea-surface temperature usage	Code table	0	1
B 25 032	Wind profiler mode information (see note 2)	Code table	0	1
B 25 033	Wind profiler submode information (see note 2)	Code table	0	1
B 25 034	Wind profiler quality control test results (see note 2)	Flag table	0	2
B 25 036	Atmospherics location method	Code table	0	2
B 25 040	CO_2 wind product derivation	Code table	0	2
B 25 041	Moving platform direction reporting method	Code table	0	1
B 25 042	Moving platform speed reporting method	Code table	0	1
B 25 043	Wave sampling interval (time)	s	4	5
B 25 044	Wave sampling interval (space)	m	2	5
B 25 045	HIRS channel combination	Flag table	0	7
B 25 046	MSU channel combination	Flag table	0	2
B 25 047	SSU channel combination	Flag table	0	2
B 25 048	AMSU-A channel combination	Flag table	0	6
B 25 049	AMSU-B channel combination	Flag table	0	2
B 25 051	AVHRR channel combination	Flag table	0	3
B 25 053	Observation quality	Flag table	0	4
B 25 060	Software identification	Numeric	0	5
B 25 070	Major frame count	Numeric	0	2
B 25 071	Frame count	Numeric	0	2
B 25 075	Satellite antenna corrections version number	Numeric	0	2
B 25 076	Log_10 of temperature-radiance central wavenumber for ATOVS	log m^{-1}	8	10
B 25 077	Bandwidth correction coefficient 1 for ATOVS	Numeric	5	7
B 25 078	Bandwidth correction coefficient 2 for ATOVS	Numeric	5	6
B 25 079	Albedo-radiance solar filtered irradiance for ATOVS	W m^{-2}	4	8
B 25 080	Albedo-radiance equivalent filter width for ATOVS	m	10	5
B 25 085	Fraction of clear pixels in HIRS FOV	Numeric	0	3

NOTES:
(1) B 25 014 nominal input range 0–2 300.
(2) The meaning of these quantities may be obtained from the originator of the data.

Class 26 – Non-coordinate location (time)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 26 001	Principal time of daily reading in UTC of maximum temperature	Hour	1	3
B 26 002	Principal time of daily reading in UTC of minimum temperature	Hour	1	3
B 26 003	Time difference	Minute	0	4
B 26 010	Hours included	Flag table	0	9

NOTE: Descriptor B 26 003 is to be used with B 08 025 (time difference qualifier).

Class 27 – Non-coordinate location (horizontal-1)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 27 001	Latitude (high accuracy)	Degree	5	7
B 27 002	Latitude (coarse accuracy)	Degree	2	4
B 27 003	Alternate latitude	Degree	2	4
B 27 020	Satellite location counter	Numeric	0	5
B 27 021	Satellite sublocation dimension	Numeric	0	5
B 27 031	In direction of 0 degrees longitude, distance from the Earth's centre	m	2	10

NOTES:

(l) The alternate latitude may be used when the computation of the position yields multiple solutions and there is no a priori way to distinguish between them.

(2) The satellite location counter is calculated as:

counter = superswath no. ¥ 1000 + box no. ¥ 10 + minibox no.

(3) The satellite sublocation dimension is calculated as:

dimension = minibox dimension + box dimension

where: minibox dimension = lines ¥ 1000 + spots ¥ 100

130 ¥ dimension = lines ¥ 10 + spots

Class 28 – Non-coordinate location (horizontal-2)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 28 001	Longitude (high accuracy)	Degree	5	8
B 28 002	Longitude (coarse accuracy)	Degree	2	5
B 28 003	Alternate longitude	Degree	2	5
B 28 031	In direction 90 degrees East, distance from the Earth's centre	m	2	10

NOTE: The alternate longitude may be used when the computation of the position yields multiple solutions and there is no a priori way to distinguish between them.

Class 29 – Map data

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 29 001	Projection type	Code table	0	1
B 29 002	Coordinate grid type	Code table	0	1

Class 30 – Image

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 30 001	Pixel value (4 bits)	Numeric	0	2
B 30 002	Pixel value (8 bits)	Numeric	0	3
B 30 004	Pixel value (l6 bits)	Numeric	0	5
B 30 021	Number of pixels per row	Numeric	0	4
B 30 022	Number of pixels per column	Numeric	0	4
B 30 031	Picture type	Code table	0	2
B 30 032	Combination with other data	Flag table	0	6

Class 33 – Quality information

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 33 002	Quality information	Code table	0	1
B 33 003	Quality information	Code table	0	1
B 33 007	% percent confidence	%	0	3
B 33 020	Quality control indication of following value	Code table	0	1
B 33 021	Quality of following value	Code table	0	1
B 33 022	Quality of buoy satellite transmission	Code table	0	1
B 33 023	Quality of buoy location	Code table	0	1
B 33 024	Station elevation quality mark (for mobile stations)	Code table	0	2

Class 33 – Quality information (*continued*)

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 33 025	ACARS interpolated values	Code table	0	1
B 33 026	Mixing ratio quality	Code table	0	2
B 33 027	Location quality class (range of radius of 66 per cent confidence)	Code table	0	1
B 33 030	Scan line status flags for ATOVS	Flag table	0	8
B 33 031	Scan line quality flags for ATOVS	Flag table	0	8
B 33 032	Channel quality flags for ATOVS	Flag table	0	8
B 33 033	Field of view quality flags for ATOVS	Flag table	0	8
B 33 035	Manual/atomatic quality control	Code table	0	2
B 33 036	Nominal confidence threshold	%	0	3
B 33 037	Wind correlation error	Flag table	0	7
B 33 040	Confidence interval	Percent	0	3

Class 35 – Data monitoring information

Reference	*Element name*	*Unit*	*Scale*	*Data width*
B 35 000	*FM and regional code number*	*Code table*	*0*	*3*
B 35 001	*Time frame for monitoring*	*Code table*	*0*	*1*
B 35 011	*Number of reports actually received*	*Numeric*	*0*	*4*
B 35 021	*Bulletin being monitored (TTAAii)*	*Character*	*0*	*6*
B 35 022	*Bulletin being monitored (YYGGgg)*	*Character*	*0*	*6*
B 35 030	*Discrepancies in the availability of expected data*	*Code table*	*0*	*1*
B 35 031	*Qualifier on monitoring results*	*Code table*	*0*	*2*
B 35 032	*Cause of missing data*	*Code table*	*0*	*1*
B 35 033	*Observation and collection deficiencies*	*Code table*	*0*	*2*
B 35 034	*Statistical trends for availability of data (during the survey period(s))*	*Code table*	*0*	*1*

CREX TABLE C – Data description operators

Reference	*Operand*	*Operator name*	*Operator definition*
C 01YYY	YYY	Data width replacement	YYY characters (from 0000 to 999) replace specified Table B data width
C 02YYY	YYY	Scale factor replacement	YYY (from -99 to 999) replaces the specified Table B scale factor
C 05YYY	YYY	Character insertion	YYY characters (from 001 to 999), including spaces, are inserted as a data field
C 07YYY	YYY	Units replacement	Change unit to unit defined in Common table C-6 by code figure equal to YYY, for example: YYY = 040 changes unit to celsius YYY = 741 changes units to km h^{-1} YYY = 201 changes units to knot YYY = 740 changes unit to km.
C 60YYY	YYY	National letters insertion (see note)	YYY national letters including spaces are inserted as a data field.

NOTE: Only the character from the International Telegraphic Alphabet No 2 (ITA2) are likely to be transmitted accurately to all recipients.

CREX Table D – Lists of common sequences

D	*X*	*Category of sequences*
D	0	CREX table entries sequences
D	01	Location and identification sequences
D	02	Meteorological sequences common to surface data
D	03	Meteorological sequences common to vertical soundings data
D	04	For satellite observations *(not to be used in CREX for transmission)*
D	*05*	*Meteorological or hydrological sequences common to hydrological observations*
D	06	Meteorological or oceanographic sequences common to oceanographic observations
D	07	Surface report sequences (land)
D	08	Surface report sequences (sea)
D	09	Vertical sounding sequences (conventional data)
D	10	Vertical sounding sequences (satellite data) *(not to be used in CREX for transmission)*

CREX **Table D – Lists of common sequences** (*continued*)

D	*X*	*Category of sequences*
D	11	Single level report sequences (conventional data)
D	12	Single level report sequences (satellite data) *(not to be used in CREX for transmission)*
D	13	Sequences common to image data *(not to be used in CREX for transmission)*
D	14	Reserved
D	15	Oceanographic report sequences
D	16	Synoptic feature sequences
D	18	Radiological report sequences
D	21	Radar report sequences *(not to be used in CREX for transmission)*
D	*35*	*Monitoring Information*

NOTES:

(1) From a conceptual point of view, Table D is not necessary:

(*a*) The Data description section can fully and completely describe the data using only element descriptors, operator descriptors and the rules of description.

(*b*) Such a means of defining the data would involve considerable overheads m terms of the length of the Data description section. Table D is a device to reduce these overheads.

(*c*) Each entry within Table D contains a list of descriptors. Each sequence descriptor that references to Table D may be 'expanded' by replacing it with the list corresponding to that entry. The process of 'expansion' is well defined, provided it results in a set of element descriptors and operator descriptors.

(*d*) Descriptors listed in entries to Table D may themselves refer to Table D, provided no circularity results on repeated expansion.

(*e*) The initial Table D has been limited to lists of descriptors likely to be frequently used. Every attempt has been made not to produce initial tables that are too comprehensive. Minor differences of reporting practice can be accommodated by not endeavoring to reduce each observation type to a single descriptor. Indeed, much more flexibility is retained if the Data description section is envisaged as containing 3 or 4 descriptors.

(2) It should be noted that, initially, effort has been concentrated on the requirements for observational data. Extensions forecast data, time series data, products, etc., follow logically, and can be added at an appropriate future date.

(3) Underwater soundings are included, with some minor omissions, to illustrate the facility to describe data of slightly different contents.

(4) Categories 48 to 63 are reserved for local use; all other categories are reserved for future development.

(5) Entries 192 to 255 within all categories are reserved for local use.

Category 01 – Location and identification sequences

Sequence	*Table reference*	*Element name*
D01030	B01018	Short station identifier
	B02001	Type of station
	D01011	Date
	D01024	Latitude and longitude, height
		(Ozone instrumentation — Brewer spectrophotometer)
D01070	B02143	Ozone instrument type
	B02142	Ozone instrument serial number or identifier
	B02144	Light source type for Brewer
		(Ozone instrumentation — Dobson spectrophotometer)
D01071	B02143	Ozone instrument type
	B02142	Ozone instrument serial number/identification
	B02145	Wavelength setting for Dobson instrument
	B02146	Source conditions for Dobson instrument
		(Ozone sounding identification)
D01075	D01001	WMO block number, WMO station number
	B01015	Station or site name
	D01022	Latitude, longitude, height of station
	B08021	18 = launch time
	D01011*	Year, month, day
	D01012	Hour, minute
		(Ozone sounding instrumentation)
D01076	B02011	Radiosonde type
	B02143	Ozone instrument type
	B02142	Ozone instrument serial number or identifier

* D01011 = (B04001+B04002+B04003) = (Year+Month+Day) may be replaced by (B04001+B04043) = (Year+Day of the year) if preferred.

Category 05 – Meteorological or hydrological sequences common to hydrological observations

Sequence	*Table reference*	*Element name*
		(SADC-HYCOS single measurement)
D05001	B11001	Wind direction
	B11002	Wind speed
	B13060	Total accumulated precipitation
	B13071	Upstream water level
		(SADC-HYCOS environmental measurement)
D05002	D01012	Hour, minute of environmental measurement
	B12001	Air temperature
	B13003	Relative humidity
	B14051	Direct solar radiation integrated over last hour
	B13060	Total accumulated precipitation
	B13072	Downstream water level
	B13080	pH
	B13081	Conductivity
	B13082	Water temperature
	B13083	Dissolved oxygen
	B13084	Turbidity
		(SADC-HYCOS measurement array definition)
D05003	D01012	Hour, minute of first single measurement minus increment
	B04065	Short time increment — time interval between measurements
	R01000	Delayed replication n times of next descriptor
	D05001	Single measurement
		(SADC-HYCOS report)
D05004	D01030	Identification
	D05002	Environmental measurement
	D05003	Measurement array
		(MEDHYCOS measurement)
D05006	B13072	Downstream water level
	B13082	Water temperature
	B13019	Precipitation last hour
	B12001	Air temperature
	B13073	Maximum water height observed
	B13060	Total accumulated precipitation
		(MEDHYCOS report)
D05007	B01018	Short station identifier
	B02001	Type of station
	D01011	Date
	D01012	Hour, minute (time of first measurement minus increment)
	B04065	Short time increment
	R01000	Delayed replication n times of next descriptor
	D05006	Single measurement
		(AOCHYCOS-Chad measurement)
D05008	D05006	Same as MEDHYCOS measurement
	B12031	Soil temperature at -50 cm
		(AOCHYCOS-Chad report)
D05009	B01018	Short station identifier
	B02001	Type of station
	D01011	Date
	D01012	Hour, minute (time of first measurement minus increment)
	B04065	Short time increment
	R01000	Delayed replication n times of next descriptor
	D05008	Single measurement

Category 06 – Meteorological or oceanographic sequences common to oceanographic observations

Sequence	*Table reference*	*Element name*
		(Tide report identification, water level checks, time period or displacement, time increment)
D06020	B01075	Tide station alphanumeric identification
	D01011	Year, month, day
	D01012	Hour, minute
	B22042	Sea/water temperature
	B22120	Tide station automated water level check
	B22121	Tide station manual water level check
	B04025	Short time period or displacement
	B04065	Short time increment
		(Meteorological parameters in tide station)
D06021	B01075	Tide station alphanumeric identification
	D01011	Year, month, day
	D01012	Hour, minute
	B22122	Tide station automated meteorological data check
	B22123	Tide station manual meteorological data check
	B12001	Air temperature
	D03002	Pressure, wind direction, wind speed
		(Tidal elevation)
D06022	B01075	Tide station identification
	D01011	Year, month, day
	D01012	Hour, minute
	B22038	Tidal elevation with respect to local chart datum
	B22039	Meteorological residual tidal elevation (surge or offset)
		(Tide elevation series)
D06024	D06020	Tide report identification, water level checks, time period or displacement, time increment
	R02006	Replicate 2 descriptors 6 times
	B22038	Tidal elevation with respect to local chart datum
	B22039	Meteorological residual tidal elevation (surge or offset)

Category 07 – Surface report sequences

Sequence	*Table reference*	*Element name*
		(Ozone data — single observation
D07030	B15001	Value of ozone measurement
	B15002	Value (harmonic mean) of the air mass
		(Ozone data — averaged observations)
D07031	B08022	Number of measurements
	B08023	First order statistics = 4: mean value
	B15001	Value (average) of ozone measurement
	B08023	First order statistics = 9: best estimate of standard deviation
	B15001	Best estimate of standard deviation of the ozone measurement
	B08023	First order statistics = 11: harmonic mean
	B15002	Value (harmonic mean) of the air mass
		(Total ozone measurement from a Brewer ground-based spectrophotometer obtained from a single observation)
D07041	D01001	Identification
	B01015	Station or site name
	D01022	Latitude, longitude, height of station
	D01011*	Year, month, day (of ozone measurement)
	D01012	Hour, minute (of ozone measurement)
	D01070	Ozone instrumentation
	D07030	Data (single observation)

* D01011 = (B04001+B04002+B04003) = (Year+Month+Day) may be replaced by (B04001+B04043) = (Year+Day of the year) if preferred.

Category 07 – Surface report sequences (*continued*)

Sequence	*Table reference*	*Element name*
		(Total ozone measurement from a Brewer ground-based spectrophotometer obtained from averaged observations)
D07042	D01001	Identification
	B01015	Station or site name
	D01022	Latitude, longitude, height of station
	D01011*	Year, month, day (of ozone measurement)
	D01012	Hour, minute (of ozone measurement)
	B08021	Time significance = 8: ensemble mean
	B04025	Time period (minutes) for the computation of the average
	D01070	Ozone instrumentation
	D07031	Data (averaged observation)
		(Total ozone measurement from a Dobson ground-based spectrophotometer obtained from a single observation)
D07043	D01001	Identification
	B01015	Station or site name
	D01022	Latitude, longitude, height of station
	D01011*	Year, month, day (of ozone measurement)
	D01012	Hour, minute (of ozone measurement)
	D01071	Ozone instrumentation
	D07030	Data (single observation)
		(Total ozone measurement from a Dobson ground-based spectrophotometer obtained from averaged observations)
D07044	D01001	Identification
	B01015	Station or site name
	D01022	Latitude, longitude, height of station
	D01011*	Year, month, day (of ozone measurement)
	D01012	Hour, minute (of ozone measurement)
	B08021	Time significance = 8: ensemble mean
	B04025	Time period (minutes) for the computation of the average
	D01071	Ozone instrumentation
	D07031	Data (averaged observation)

* D01011 = (B04001+B04002+B04003) = (Year+Month+Day) may be replaced by (B04001+B04043) = (Year+Day of the year) if preferred.

Category 09 – Vertical sounding sequences (conventional data)

Sequence	*Table reference*	*Element name*
		(Ozone sonde flight data)
D09030	B15004	Ozone sounding correction factor
	B15005	Ozone p
	R04000	Delayed replication
	B04015	Time increment since launch time, if needed; in minutes
	B08006	Ozone vertical sounding significance
	B07004	Pressure
	B15003	Measured ozone partial pressure
		(Ozone sounding not coupled to a ground-based spectrophotometer)
D09040	D01075	Identification
	D01076	Instrumentation
	D09030	Ozone flight data
		(Ozone sounding coupled to measurements from a Brewer ground-based spectrophotometer; the total ozone obtained from the Brewer is a single value)
D09041	D07041	Description of the ground-based part
	D01075	Identification of the ozone sounding part
	D01076	Instrumentation of sounding
	D09030	Ozone flight data

Category 09 – Vertical sounding sequences (conventional data) (*continued*)

Sequence	*Table reference*	*Element name*
		(Ozone sounding coupled to measurements from a Brewer ground-based spectrophotometer; the total ozone obtained from the Brewer is an averaged value)
D09042	D07042	Description of the ground-based part
	D01075	Identification of the ozone sounding part
	D01076	Instrumentation of sounding
	D09030	Ozone flight data
		(Ozone sounding coupled to measurements from a Dobson ground-based spectrophotometer; the total ozone obtained from the Dobson is a single value)
D09043	D07043	Description of the ground-based part
	D01075	Identification of the ozone sounding part
	D01076	Instrumentation of sounding
	D09030	Ozone flight data
		(Ozone sounding coupled to measurements from a Dobson ground-based spectrophotometer; the total ozone obtained from the Dobson is an averaged value)
D09044	D07044	Description of the ground-based part
	D01075	Identification of the ozone sounding part
	D01076	Instrumentation of sounding
	D09030	Ozone flight data

Category 16 – Synoptic feature sequences

Sequence	*Table reference*	*Element name*
		(Tropical storm identification)
D16020	B01033	Identification of originating/generating centre
	B01025	Storm identifier
	B01026	WMO storm name
	D01011	Year, month, day
	D01012	Hour, minute
		(Analysis data)
D16021	D01023	Latitude (coarse accuracy), longitude (coarse accuracy)
	B02041	Method for estimating reports related to synoptic features
	B19001	Type of synoptic feature
	B19007	Effective radius of feature
	B19005	Direction of motion of feature
	B19006	Speed of motion of feature
	B19008	Vertical extent of feature
	B08005	Surface synoptic feature significance (value=1 for storm centre)
	B10004	Pressure (of storm centre by virtue of preceding significance qualifier)
	B08005	Value = 2 for outer limit or edge of feature
	B10004	Pressure (at outer limit)
	B19007	Radius (of outer limit)
	B08005	Value = 3 for location of maximum wind
	B08021	Time significance (time averaged)
	B04075	Time period (minutes)
	B11040	Maximum wind speed (mean wind)
	B19007	Radius of feature (max wind)
	R05004	(4 times replication of following 5 descriptors)
	B05021	Starting bearing or azimuth
	B05021	Ending bearing or azimuth
	R02002	(2 times replication of following 2 descriptors)
	B19003	Wind speed threshold
	B19004	Effective radius with respect to wind speed above threshold

Category 16 – Synoptic feature sequences (*continued*)

Sequence	*Table reference*	*Element name*
		(Forecast data)
D16022	B01032	Generating application (NWP model name, etc. code table defined by originating/generating centre)
	B02041	Method for estimating reports related to synoptic features
	B19001	Type of synoptic feature
	B19010	Method for tracing of the centre of synoptic feature
	R18000	NN times replication of following 18 descriptors — delayed replication)
	B08021	Time significance (forecast)
	B04014	Time increment (hour)
	B08005	Surface synoptic feature significance
	D01023	Latitude (coarse accuracy), longitude (coarse accuracy)
	B19005	Direction of motion of feature
	B19006	Speed of motion of feature
	B10004	Pressure
	B11041	Maximum wind speed (gusts: e.g. used in United States)
	B08021	Time significance (forecast time averaged)
	B04075	Time period (minutes)
	B11040	Maximum wind speed (mean wind)
	B19008	Vertical extent of feature
	R05004	(4 times replication of following 5 descriptors)
	B05021	Starting bearing or azimuth
	B05021	Ending bearing or azimuth
	R02002	(2 times replication of following 2 descriptors)
	B19003	Wind speed threshold
	B19004	Effective radius with respect to wind speed above threshold
		(Tropical storm analysis information)
D16026	D16020	Tropical storm identification
	D16021	Analysis data
		(Tropical storm forecast information)
D16027	D16020	Tropical storm identification
	D16022	Forecast data

Category 35 – Monitoring information

Sequence	*Table reference*	*Element name*
		(Specify monitoring station)
D35001	B08035	Type of monitoring exercise
	B35001	Time frame for monitoring
	B08036	Type of centre or station performing monitoring
	D01001	WMO block and station number
		(Specify monitoring centre)
D35002	B08035	Type of monitoring exercise
	B35001	Time frame for monitoring
	B08036	Type of centre or station performing monitoring
	B01033	Identification of originating/generating centre
		(Specify monitoring period)
D35003	B08021	(23) monitoring period
	B04001	Year
	B04002	Month
	B04003	Day
	B04004	Hour
	B04073	Short period or displacement

Category 35 – Monitoring information (*continued*)

Sequence	*Table reference*	*Element name*
		(Specify report type and single station being monitored)
D35004	B08021	(24) agreed time limit for report reception
	B04004	Hour
	B08021	(25) nominal reporting time
	B04004	Hour
	B35000	FM and regional code number
	D01001	(WMO station identifier)
	B35011	Number of reports actually received
		(Specify report type and WMO block being monitored)
D35005	B08021	(24) agreed time limit for report reception
	B04004	Hour
	B08021	(25) nominal reporting time
	B04004	Hour
	B35000	FM and regional code number
	B01001	WMO block number
	B35011	Number of reports actually received
		(Specify report type and WMO Region being monitored)
D35006	B08021	(24) agreed time limit for report reception
	B04004	Hour
	B08021	(25) nominal reporting time
	B04004	Hour
	B35000	FM and regional code number
	B01003	WMO region/geographical area
	B35011	Number of reports actually received
		(Report type and multiple stations from one block being monitored)
D35007	B08021	(24) agreed time limit for report reception
	B04004	Hour
	B08021	(25) nominal reporting time
	B04004	Hour
	B35000	FM and regional code number
	B01001	WMO block number
	R02000	Delayed replication (2 descriptors) — count of stations
	B01002	WMO station number
	B35011	Number of reports actually received
		(Monitoring a report type from multiple stations)
D35010	D35002	(Specify monitoring centre)
	D35003	(Specify monitoring period)
	D35007	(Specify report type and multiple stations being monitored)

CREX TEMPLATE EXAMPLES

PROPOSED BLOEMHOF FLOOD MONITORING CREX CODE (HYDROLOGY)

INDICATOR SECTION AND DATA DESCRIPTION SECTION
CREX++
T000101 A000 D05004++
STATION IDENTIFICATION
Sequence: D01030 consisting of

B01018 : WMO station identifier
B02001 : Type of station
D01011 : Date
D01024 : Latitude and longitude and height

HOURLY ENVIRONMENTAL DATA
Sequence: D05002 consisting of

D01012 :	Time (hour, minute)
B12001 :	Air temperature
B13003 :	Relative humidity
B14051 :	Direct solar radiation during the last hour
B13060 :	Total accumulated precipitation (modulo 10 000 kg/m^2)
B13072 :	Downstream water level
B13080 :	pH
B13081 :	Conductivity
B13082 :	Water temperature
B13083 :	Dissolved oxygen
B13084 :	Turbidity

MULTIPLE MEASUREMENT ARRAY DEFINITION
Sequence: D05003 consisting of

D01012 :	Time of first measurement (hour, minute) minus increment
B04065 :	Short-time increment — Time interval between measurements in the array (12 minutes)
R01000 :	Delayed replication of one next descriptor (D05001) — Number of measurements in the array (5)
D05001 :	Single measurement

SINGLE MEASUREMENT
Sequence: D05001 consisting of

B11001 :	Wind direction
B11002 :	Wind speed
B13060 :	Total accumulated precipitation (modulo 10 000 kg/m^2)
B13071 :	Upstream water level

END OF MESSAGE
...++
7777

Thus the format of the message D05004 for the BLOEMHOF Flood Monitoring System will be:
Indicator section and data description section then:

D01030	: Identification
D05002	: Hourly instantaneous values
D05003	: Array definition
n x D05001	: Multiple measurements
++ 7777	: End of message

EXAMPLE
A CREX message transmitted at 10:46 a.m. would be the following:

```
CREX++
T0101 A000 D05004++
12345 2 1998 02 03 -2600 2800 01570
10 00 285 065 0326 03842 0683 0075 2600 2805 //// 0156
09 00 12 0005
290 0102 00012 1226
250 0250 00025 1230
245 0175 00028 1235
230 0105 00004 1241
220 0025 00001 1249++
7777
```

Note that: (the + at end of lines are not needed, only at the end of the whole report (in that case after 1249 -— last line) and only if a whole message was to be repeated, one or more times. The whole message from 12345 to 1249 is called a “subset”. See regulation 95.4.1) The space before -2600 is required for transmission purpose, but optional for display (to keep alignment). Fifth line, last group = delayed replication — 4 digits only = 0005.

Line 1: message identification
Line 3:
Station number: 12345
Station type: 2
Date of main measurement: 3rd Feb 1998
Position of station: 26 degrees south, 28 degrees east, 1570 m high
Line 4:
Time of hourly measurement: 10:00
Air temperature at 10H00: 28,50C
Relative humidity at 10H00: 65%
Direct solar radiation integrated over the period 9H00 to 10H00: 326000 J/m2
Total accumulated precipitation at 10H00: 0384.2 kg/m2
Down Stream Water Level at 10H00: 6,83m
Water pH: 7.5
Conductivity at 10H00: 2,6 Siemens/m = 26 mS/cm
Water temperature at 10H00: 280,5K
Dissolved oxygen at 10H00: Not available
Turbidity at 10H00: 156 NTU
Line 5: Measurement array definition
First measurement minus 12 minutes at 9H00
Interval between measurements is 12 minutes
Number of measurements is 5
Line 6: First set of measurements at 09H12
Instantaneous wind direction at 9H12: 2900
Instantaneous wind speed at 9H12: 10,2 m/s
Total precipitation between 9H00 and 9H12: 1,2 kg/m2
Upstream water level at 9H12: 12,26m
Line 7: Second set of measurements at 09H24
Instantaneous wind direction at 9H24: 2500
Instantaneous wind speed at 9H24: 25,0 m/s
Total precipitation between 9H12 and 9H24: 2,5 kg/m2
Upstream water level at 9H24: 12,30m
Line 8: Third set of measurements at 09H36
Instantaneous wind direction at 9H36: 2450
Instantaneous wind speed at 9H36: 17,5 m/s
Total precipitation between 9H36 and 9H12: 2,8 kg/m2
Upstream water level at 9H36: 12,35m
Line 9: Fourth set of measurements at 09H48
Instantaneous wind direction at 9H48: 2300
Instantaneous wind speed at 9H48: 10,5 m/s
Total precipitation between 9H48 and 9H12: 0,4 kg/m2
Upstream water level at 9H48: 12,41m
Line 10: Fifth set of measurements at 10H00
Instantaneous wind direction at 10H00: 2200
Instantaneous wind speed at 10H00: 2,5 m/s
Total precipitation between 10H00 and 9H12: 0,1 kg/m2
Upstream water level at 10H00: 12,49m
Line 11: End of message identifier

TIDE GAUGE DATA EXAMPLE

```
CREX++
T000101 A001 D06024++
RI010 1998 01 23 15 00 2761 00 00 30 -30
01407 1225 01384 1217 01382 1221 01395 1220 01473 1262 01502 1227+
CT010 1998 01 23 15 00 2781 01 00 30 -30
02024 1757 02043 1717 02124 1728 02177 1716 ///// //// 02259 1670++
7777
```

Interpretation of the example:

Line	*Group*	*Meaning*
1	CREX	Indicator of a CREX message
2	T000101	CREX Master Table Number 00, Edition 01, Version 01
	A0001	Data type 001: Surface data — sea
	D06024	Tide elevation series
3	RI010	Tide station RI010
	1998	Year: 1998
	01	Month: January
	23	Day: 23
	15	Hour: 1500 UTC
	00	Minute: 00
	2761	Sea/water temperature: 276.1 K
	00	Tide station automated water level check: Good data
	00	Tide station manual water level check: Operational
	30	Short time period or displacement: time is not hour 1500, minute 30
	-30	Short time increment: increment is applied prior to each replication of two descriptors indicated by the group R02006, thus the time is now hour 1500, minute 00
4	01407	Tide elevation of 1407 mm at hour 1500, minute 00
	1225	Meteorological residual tidal elevation of 1225 mm at hour 1500, minute 00
	01384	Tide elevation of 1384 mm at hour 1400, minute 30
	1217	Meteorological residual tidal elevation of 1217 mm at hour 1400, minute 30
	01382	Tide elevation of 1382 mm at hour 1400, minute 00
	1221	Meteorological residual tidal elevation of 1221 mm at hour 1400, minute 00
	01395	Tide elevation of 1395 mm at hour 1300, minute 30
	1220	Meteorological residual tidal elevation of 1220 mm at hour 1300, minute 30
	01473	Tide elevation of 1473 mm at hour 1300, minute 30
	1262	Meteorological residual tidal elevation of 1262 mm at hour 1300, minute 00
	01502	Tide elevation of 1502 mm at hour 1200, minute 30
	1227	Meteorological residual tidal elevation of 1227 mm at hour 1200, minute 30
	+	End of report for station RI010
5	CT010	Tide station CT010
	1998	Year: 1998
	01	Month: January
	23	Day: 23
	15	Hour: 1500 UTC
	00	Minute: 00
	2761	Sea/water temperature: 276.1 K
	00	Tide station automated water level check: Good data
	00	Tide station manual water level check: Operational
	30	Short time period or displacement: time is not hour 1500, minute 30
	-30	Short time increment: increment is applied prior to each replication of two Descriptors indicated by the group R02006, thus the time is not hour 1500, minute 00
6	02024	Tide elevation of 2024 mm at hour 1500, minute 00
	1715	Meteorological residual tidal elevation of 1715 mm at hour 1500, minute 00
	02043	Tide elevation of 2043 mm at hour 1400, minute 30
	1717	Meteorological residual tidal elevation of 1717 mm at hour 1400, minute 30
	02124	Tide elevation of 2124 mm at hour 1400, minute 00
	1728	Meteorological residual tidal elevation of 1728 mm at hour 1400, minute 00
	02177	Tide elevation of 2177 mm at hour 1300, minute 30
	1716	Meteorological residual tidal elevation of 1716 mm at hour 1300, minute 30
	/////	Tide elevation missing at hour 1300, minute 30
	////	Meteorological residual tidal elevation missing at hour 1300, minute 00
	02259	Tide elevation of 2259 mm at hour 1200, minute 30
	1670	Meteorological residual tidal elevation of 1670 mm at hour 1200, minute 30
	++	End of report for station CT010; also, end of data section
7	7777	End of CREX message

TOTAL OZONE MEASUREMENT FROM A DOBSON GROUND-BASED SPECTROPHOTOMETER OBTAINED FROM A SINGLE OBSERVATION

```
CREX++
T000101 A008 D07043++
11 649 Hradec Kralove  5018 01583 00290 1998 03 09 10 03 003 74 00 00 0415 180++
7777
```

CREX		
T000101		
A008		
D07043		
D01001		
B01001	WMO block number	11
B01002	WMO station number	649
B01015	Station or site name	Hradec Kralove
D01022		
B05002	Latitude	5018
B06002	Longitude	01583
B07001	Height of station	00290
D01011		
B04001	Year (of ozone measurement)	1998
B04002	Month (of ozone measurement)	03
B04003	Day (of ozone measurement)	09
D01012		
B04004	Hour (of ozone measurement)	10
B04005	Minute (of ozone measurement)	03
D01071		
B02143	Ozone instrument type	003
B02142	Ozone instrument serial number	74
B02145	Wave length setting for Dobson instruments	00
B02146	Source condtions for Dobson instruments	00
D07030		
B15001	Value of ozone measurement	0415
B15002	Value (harmonic mean) of the air mass	180
7777		

EXAMPLE OF AN OZONE SOUNDING COUPLED TO A BREWER SPECTROPHOTOMETER

NOTE: ^ means space in the definitions below

CREX++			
T000101			
A008			
D01001	:	WMO station	71
		WMO block number	913
B01015	:	Station or site name	Churchill^^^^^^^^^^^
D01022	:	Latitude	5875
		Longitude	-09400
		Elevation	00029
D01011	:	Year	1998
		Month	04
		Day	29
D01012	:	Hours	13
		Minutes	46
B08021	:	Time significance = 8 = ensemble mean	08
B04025	:	Time period (minutes)	0550
D01070	:	Ozone instrument type	001
		Ozone instrument serial number (Brewer)	26^^
		Light source type for Brewer (direct sun)	00

B08022	:	Number of measurements	00010
B08023	:	First order statistics = 4 = mean value	04
B15001	:	Value of ozone measurement	0399
B08023	:	First order statistics = 9 = best estimate of standard deviation	09
B15001	:	Best estimate of standard deviation	0010
B08023	:	First order statistics = harmonic mean	11
B15002	:	Harmonic mean of the air mass	202
D01001	:	WMO station and block number	71
			913
B01015	:	Station or site name	Churchill^^^^^^^^^^^
D01022	:	Latitude	5875
		Longitude	-09400
		Elevation	00029
B08021	:	18 = launch time follows	18
D01011	:	Year	1998
		Month	04
		Day	29
D01012	:	Hours	11
		Minutes	22
B02011	:	Radiosonde type	061
B02143	:	Ozone instrument type	019
B02142	:	Ozone sonde serial number	////
D15004	:	Ozone sounding correction factor	0893
D15005	:	Ozone p	373
R04000	:	Delayed replication factor = number of levels	0093
		The next four descriptors are repeated 93 times	
B04015	:	Time increment since launch time (minutes)	see below
B08006	:	Ozone VSS	see below
B07004	:	Pressure	see below
B15003	:	Measured ozone partial pressure	see below
++			
7777	end of message		

```
KULA01 CWAO 051800
CREX++
T000101 A008 D09042++
71 913 CHURCHILL  5875 -09400 00029 1998 04 29 13 46
   08 0550 001 26 00 00010 04 0399 09 0010 11 202
   71 913 CHURCHILL  5875 -09400 00029 18 1998 04 29 11 22
   061 019 //// 0893 373 0093
   0000 400 10041 029 0000 200 10000 029 0000 002 09915 031
   0001 002 09735 036 0001 002 09678 038 0002 002 09273 038
   0003 002 09111 039 0004 200 08500 039 0009 200 07000 037
   0011 002 06450 037 0012 002 06279 036 0012 002 06159 031
   0014 002 05847 034 0016 002 05347 030 0016 002 05269 029
   0017 002 05100 040 0018 200 05000 034 0019 002 04821 030
   0023 200 04000 030 0027 002 03400 026 0029 002 03000 028
   0031 002 02857 029 0031 002 02818 024 0032 002 02743 017
   0034 200 02500 015 0036 002 02225 014 0038 002 02078 029
   0038 002 02049 036 0039 200 02000 066 0039 002 01992 066
   0039 002 01952 093 0040 002 01909 105 0040 002 01866 105
   0041 002 01800 115 0042 002 01765 103 0042 002 01741 100
   0043 002 01693 112 0043 002 01656 112 0044 002 01612 109
   0044 002 01590 092 0044 002 01580 066 0045 002 01559 052
   0045 002 01517 049 0046 002 01500 059 0046 002 01488 070
   0046 002 01469 098 0047 002 01440 107 0047 002 01391 107
   0048 002 01335 117 0049 002 01291 162 0050 002 01257 153
```

```
  0051 002 01206 155 0051 002 01190 141 0051 002 01182 141
  0052 002 01142 156 0053 002 01103 154 0054 002 01059 177
  0055 002 01005 170 0056 200 01000 178 0056 002 00978 197
  0057 002 00951 187 0058 002 00914 183 0058 002 00889 171
  0059 002 00866 182 0059 002 00855 195 0060 002 00837 198
  0061 002 00808 175 0061 002 00797 172 0064 200 00700 160
  0065 002 00671 157 0067 002 00630 142 0068 002 00592 153
  0068 002 00583 162 0070 002 00531 157 0072 002 00501 164
  0072 200 00500 161 0073 002 00479 162 0073 002 00462 151
  0075 002 00435 156 0076 002 00418 153 0078 002 00378 161
  0081 002 00319 132 0082 002 00311 136 0083 200 00300 130
  0086 002 00258 111 0091 200 00200 095 0097 002 00143 079
  0099 002 00126 078 0103 200 00100 071 0110 200 00070 058
  0115 002 00054 044 0116 200 00050 039 0120 002 00043 032++
7777
```

EXAMPLE OF AN OZONE SOUNDING NOT COUPLED TO A BREWER SPECTROPHOTOMETER

```
CREX++
T000101
A008
        D01001    :    WMO station and block number                71
                                                                     917
        B01015    :    Station or site name                        Eureka^^^^^^^^^^^^^^
        D01022    :    Latitude                                    7598
                       Longitude                                   -08593
                       Elevation                                   00010
        B08021    :    18 = launch time follows                    18
        D01011    :    Year                                        1998
                       Month                                       04
                       Day                                         29
        D01012    :    Hours                                       23
                       Minutes                                     18
        B02011    :    Radiosonde type                             061
        B02143    :    Ozone instrument type                       019
        B02142    :    Ozone sonde serial number                   ////
        D15004    :    Ozone sounding correction factor            ////
        D15005    :    Ozone p                                     375
        R04000    :    Delayed replication factor = number of levels  0082
                       The next four descriptors are repeated 82 times
        B04015    :    Time increment since launch time (minutes)  see below
        B08006    :    Ozone VSS                                   see below
        B07004    :    Pressure                                    see below
        B15003    :    Measured ozone partial pressure             see below
        ++
        7777       end of message

KULA01 CWAO 051800
CREX++
T000101 A008 D09040++
71 917 EUREKA  7598 -08593 00010 18 1998 04 29 23 18
  061 019 //// //// 375 0082
  0000 400 10137 030 0000 200 10000 030 0001 002 09687 037
  0002 002 09366 033 0004 002 08831 037 0005 200 08500 036
  0007 002 08013 043 0007 002 07881 047 0008 002 07646 037
  0009 002 07442 042 0011 200 07000 031 0012 002 06849 027
  0013 002 06710 036 0015 002 06291 029 0022 200 05000 028
  0025 002 04557 027 0029 002 04065 024 0029 200 04000 020
  0032 002 03626 025 0038 002 03000 020 0040 002 02890 021
```

```
  0040 002 02829 065 0041 002 02726 105 0043 002 02576 118
  0044 200 02500 135 0048 002 02218 165 0049 002 02147 161
  0050 002 02104 171 0051 002 02031 153 0051 002 02010 159
  0051 200 02000 171 0052 002 01941 188 0054 002 01854 198
  0056 002 01744 187 0056 002 01717 194 0057 002 01683 191
  0058 002 01640 161 0058 002 01623 159 0059 002 01585 168
  0059 002 01576 185 0060 002 01545 197 0061 002 01500 202
  0063 002 01414 221 0064 002 01370 220 0065 002 01335 230
  0066 002 01269 219 0067 002 01232 227 0067 002 01226 235
  0068 002 01208 241 0072 002 01055 242 0074 200 01000 236
  0075 002 00960 228 0076 002 00936 192 0077 002 00912 180
  0078 002 00897 187 0078 002 00883 210 0079 002 00868 221
  0079 002 00850 202 0080 002 00841 199 0081 002 00815 208
  0081 002 00807 189 0081 002 00803 171 0082 002 00790 152
  0082 002 00777 157 0083 002 00764 172 0084 002 00741 156
  0084 002 00722 156 0085 002 00715 162 0085 200 00700 188
  0085 200 00700 193 0086 002 00682 203 0088 002 00639 212
  0090 002 00608 206 0091 002 00588 190 0091 002 00582 192
  0092 002 00570 209 0092 002 00557 215 0096 200 00500 197
  0099 002 00437 171 0108 002 00316 139 0110 200 00300 128
  0115 002 00242 108++
7777
```

SAMPLE DATA WITH CREX SEQUENCE FOR THE EXCHANGE OF FORECAST RESULT ON TROPICAL CYCLONES

Descriptor	*Order No.*	*Sample data*	*Corresponding meaning*	*Unit*	*Scale*	*Data width*
B 01 033	1	034	Originating centre = RSMC Tokyo	Code table	0	3
B 01 025	2	21W	Storm identifier	Character	0	3
B 01 026	3	ZANE	WMO storm name	Character	0	8
D 01 011			(sequence descriptor)			
B 04 001	4	1996	Year	Year	0	4
B 04 002	5	10	October	Month	0	2
B 04 003	6	01	1st	Day	0	2
D 01 012			(sequence descriptor)			
B 04 004	7	06	6 o'clock (UTC)	Hour	0	2
B 04 005	8	00	0 minute (UTC)	Minute	0	2
B 01 032	9	XXX	(to be defined)			
			Identification of NWP model	Code table	0	3
B 02 041	0	01	Based on computer analysis	Code table	0	2
B 19 001	1	02	Tropical storm	Code table	0	2
B 19 010	2	01	Minimum value of sea level pressure	Code table	0	2
R 18 000	3	0003	(***delayed replication descriptor***)	Numeric	0	4
			Data for 3 forecast times of 18 descriptors follow			
B 08 021	4	04	Forecast data follow	Code table	0	2
B 04 014	5	0012	12 hour forecast data follow	Hour	0	4
B 08 005	6	01	Data of storm centre follow	Code table	0	2
D 01 023			(sequence descriptor)			
B 05 002	7	3010	Latitude of the storm centre is 30.1N	Degree	2	4
B 06 002	8	14200	Longitude of the storm centre is 142.0E	Degree	2	5
B 19 005	9	270	Direction of motion of storm is 270	Degree true	0	3
B 19 006	0	00500	Speed of motion of storm is 5m/s	m/s	2	5
B 10 004	1	09750	Pressure of storm centre is 975hPa	Pa	-1	5
B 11 041	2	0576	Gust wind speed is 57.6 m/s	m/s	1	4
B 08 021	3	06	Forecast time averaged follow	Code table	0	2
B 04 075	4	10	10 minutes mean value follow	Minute	0	2

Descriptor	*Order No.*	*Sample data*	*Corresponding meaning*	*Unit*	*Scale*	*Data width*
B 11 040	5	0360	Maximum wind speed is 36.0 m/s	m/s	1	4
B 19 008	6	2	Storm depth is medium	Code table	0	1
R 05 004			***(replication descriptor)			
			4 times replication of following 5 descriptors			
B 05 021	7	31500	sector 1 (from 315 deg.	Degree true	2	5
B 05 021	8	04500	to 45 deg.)	Degree true	2	5
R 02 002			***(replication descriptor)			
			2 times replication of following 2 descriptors			
B 19 003	9	025	Wind speed threshold is 25m/s	m/s	0	3
B 19 004	0	1950	Effective radius is 195 km	m	-2	4
	1	015	Wind speed threshold is 15m/s			
	2	4000	Effective radius is 400 km			
	3	04500	sector 2 (from 45 deg.			
	4	13500	to 135 deg.)			
	5	025	Wind speed threshold is 25m/s			
	6	1950	Effective radius is 195 km			
	7	015	Wind speed threshold is 15m/s			
	8	4300	Effective radius is 430 km			
	9	13500	sector 3 (from 135 deg.			
	0	22500	to 225 deg.)			
	1	025	Wind speed threshold is 25m/s			
	2	1950	Effective radius is 195 km			
	3	015	Wind speed threshold is 15m/s			
	4	6090	Effective radius is 609 km			
	5	22500	sector 4 (from 225 deg.			
	6	31500	to 315 deg.)			
	7	025	Wind speed threshold is 25m/s			
	8	1950	Effective radius is 195 km			
	9	015	Wind speed threshold is 15m/s			
	0	4700	Effective radius is 470 km			
1	04		(24 and 36 hour forecast data follow as same as			
.....			the second fourth order above)			

CREX MESSAGE COMPOSED OF ABOVE DATA ELEMENTS:

CREX++
T000101 A007 B01033 B01025 B01026 D01011 D01012 B01032 B02041 B19001 B19010 R18000 B08021 B04014 B08005 D01023 B19005 B19006 B10004 B11041 B08021 B04075 B11040 B19008 R05004 B05021 B05021 R02002 B19003 B19004 E++
0034 121W 2ZANE 31996 410 501 606 700 8XXX 901 002 101 20003 304 40012 501 63010 714200 8270 900500 009750 10576 206 310 40360 52 631500 704500 8025 91950 0015 14000 204500 313500 4025 51950 6015 74300 813500 922500 0025 11950 2015 36090 422500 531500 6025 71950 8015 94700 004 .....++
7777

or (with big common sequence definition)
CREX++
T000101 A007 D16027E++
0034 121W 2ZANE 31996 410 501 606 700 8XXX 901 002 101 20003 304 40012 501 63010 714200 8270 900500 009750 10576 206 310 40360 52 631500 704500 8025 91950 0015 14000 204500 313500 4025 51950 6015 74300 813500 922500 0025 11950 2015 36090 422500 531500 6025 71950 8015 94700 004 .....++
7777

or without check digit:
CREX++
T000101 A007 D16027++
034 21W ZANE 1996 10 01 06 00 XXX 01 02 01 0003 04 0012 01 3010 14200 270 00500 09750 0576 06 10 0360 2 31500 04500 025 1950 015 4000 04500 13500 025 1950 015 4300 13500 22500 025 1950 015 6090 22500 31500 025 1950 015 4700 04 .....++
7777

MONITORING INFORMATION SAMPLE MESSAGE

CREX++	(indicator section)
T000101 A020 D35010++	(description section)
1 2 4 014 23 1996 10 01 00 15 24 06 25 00 012 63 0003 740 0360 894 353	
792 0125++	(data section)
7777	(end section)

1	Regional exercise
2	Non-real time
4	RTH
014	Nairobi
23	Monitoring period follows
1996	YYYY
10	MM
01	DD
00	HH
15	Days duration
24	Data cut off follows
06	Hours
25	Report time follows
00	Hours
012	SYNOP
63	Block number
0003	Stations
740	Nairobi
0360	Well done
894	Dar es Salam
0353	Very good
792	A station
0125	Must do better!

++
7777

RECOMMENDATION 6 (CBS-Ext.(98))

AMENDMENTS TO THE *MANUAL ON CODES* (WMO-No. 306), VOLUME I.1, ALPHANUMERIC CODES AND VOLUME I.2, BINARY CODES AND COMMON FEATURES

THE COMMISSION FOR BASIC SYSTEMS,

NOTING:

(1) Resolution 5 (CBS-XI) — Working Group on Data Management,

(2) The report of the meeting of the Subgroup on Data Representation and Codes (20–24 April 1998),

(3) The report of the third session of the Working Group on Data Management (8-12 June 1998),

(4) The *Abridged Final Report with Resolutions and Recommendations of the Eleventh Session of the Commission for Basic System* (WMO-No. 854), general summary paragraph 6.4.34,

CONSIDERING the requirements:

(1) (*a*) For additions requested by the Data Buoy Cooperation Panel on Encoding Buoy Data,

(*b*) For addition of entries for coding the equivalent of the code FM 82 SFLOC (Atmospherics),

(*c*) For new data descriptors for precipitation data,

(*d*) For the introduction of agreed new CREX entries (mainly for hydrology, ozone and tide gauge data),

(*e*) For the introduction of a clarification in the BUFR regulations for the compression method of character arrays and for bit length per character,

(2) (*a*) For addition of a new Common Code Table C-6 containing the list of units which may be used in CREX (and other WMO Codes),
(*b*) For addition of a new Common Table C-8 containing a comprehensive list of all instruments flown by satellites,

(3) (*a*) For amendment to the regulation for clarification in reporting past weather in SYNOP,
(*b*) For provision for regional practice data (Section 5 of FM 32-34, Section 9 of FM 35-38) and national practice data (Section 6 of FM 32-34, Section 10 of FM 35-38) to Part A and Part C of the PILOT and TEMP code forms,
(*c*) For inclusion of section 7 (launch time and type of radiosonde), already in Part B, in all the other sections of the TEMP report,
(*d*) For regulation in TEMP defining the layer of wind missing values,
(*e*) For addition of day (YY) to time group (GGgg) in AMDAR (to identify without ambiguity the observations and avoid loss of data),
(*f*) For updates to BATHY and TESAC (instruments information and accuracy of location),
(*g*) For addition of a note in WAVEOB (to indicate that some optional section ought to be present when other sections were coded),
(*h*) For adding a code table to define data processing technique used when retrieving satellite data (I_4 in SATEM and SARAD),
(*i*) For suppression in section 2 of the Appendix to Volume I.1 of the *Manual on Codes* (WMO-No. 306) related to units used for the wind in the various code forms by every country,

RECOMMENDS that the following amendments be adopted for use as from 3 May 2000:

(1) Amendments to FM 94-XI BUFR regulations and tables, defined in Annex 1 to this recommendation;
(2) Additions of Common Tables, defined in Annex 2 to this recommendation;
(3) Amendments to FM 12-XI SYNOP, FM 13-XI SHIP, FM 14-XI SYNOP MOBIL, FM 32-IX PILOT, FM 33-IX PILOT SHIP, FM 34-IX PILOT MOBIL, FM 35-X Ext. TEMP, FM 36-X Ext. TEMP SHIP, FM 37-X Ext. TEMP DROP, FM 38-X Ext. TEMP MOBIL, FM 42-XI AMDAR, FM 63-X Ext. BATHY, FM 64-IX TESAC and FM 65-XI WAVEOB, and new code table to define data processing technique used when retrieving satellite data (I_4 in SATEM and SARAD), defined in Annex 3 to this recommendation;
(4) Suppression of Appendix 2.: Units used for the reporting of horizontal speed (wind speed, speed of a system, etc..) in Volume I.1 of the *Manual on Codes* (WMO-No. 306);

REQUESTS the Secretary-General to arrange for the inclusion of these amendments in Volumes I.1 and I.2 of the *Manual on Codes* (WMO-No. 306).

ANNEX 1 TO RECOMMENDATION 6 (CBS-Ext.(98))

AMENDMENTS TO FM 94-XI BUFR REGULATIONS AND TABLES

1. ADDITIONS REQUESTED BY THE DATA BUOY COOPERATION PANEL ON ENCODING BUOY DATA

Proposed new code tables or flag tables associated to BUFR Table B or new entries

1.1 – *Type of data buoy* (code table)

Descriptor	Scale	Reference	Number bits
0 02 149	0	0	6

Code figure	
0	Unspecified drifting buoy
1	Standard Lagrangian drifter (global drifter programme)
2	Standard FGGE type drifting buoy (non Lagrangian meteorological drifting buoy)
3	Wind measuring FGGE type drifting buoy (non Lagrangian meteorological drifting buoy)
4	Ice float
5–7	Reserved
8	Unspecified sub-surface float
9	SOFAR
10	ALACE
11	MARVOR
12	RAFOS
13–15	Reserved
16	Unspecified moored buoy

Code figure	
17	Nomad
18	3-metre discus
19	10–12 metre discus
20	ODAS 30 series
21	ATLAS (e.g. TAO area)
22	TRITON buoy
23	Reserved
24	Omnidirectional wave-rider
25	Directional waverider
26–62	Reserved
63	Missing value

1.2 – *Location system* (code table)

Descriptor	Scale	Reference	Number bits
0 02 148	0	0	5

Code figure	
0	Reserved
1	Argos
2	GPS
3–30	Reserved
31	Missing value

1.3 – *Confidence interval* (per cent)

Descriptor	Scale	Reference	Number bits
0 33 040	0	0	7

1.4 – *Radius of confidence* (m)

Descriptor	Scale	Reference	Number bits
0 06 040	0	0	13

1.5 – *Platform transmitter ID number* (numeric)

Descriptor	Scale	Reference	Number bits
0 01 050	0	0	17

1.6 – *Platform transmitter ID number* (CCITT IA5)

Descriptor	Scale	Reference	Number bits
0 01 051	0	0	96

1.7 – *Drogue depth* (m)

Descriptor	Scale	Reference	Number bits
0 07 070	0	0	10

1.8 – *New entries in code table 0 08 021, "Time Significance"*:

(*a*) Do not need location time since you can deliver the time before the latitude and longitude and this time will be associated with the position.

(*b*) To record sampling period use 0 04 025 properly associated with the observations for which this applies.

(*c*) Time of gust is given by another time that is associated with the gust information.

An example of the ordering of elements to accomplish what was requested is as follows.

Time (location)
Position
Time (gust)
Gust (observation)
Time (observation)
Instantaneous observations
Time period or displacement (minutes)
Observations

1.9 – New entry 5 in table 0 08 030 (Table 2266 in Volume I.1) Method of current measurement
The table now looks as follows:

Code figure	
0–1	Reserved
2	GEK (geomagnetic electrokinetograph)
3	Ship's set and drift determined by fixes 3–6 hours apart
4	Ship's set and drift determined by fixes more than 6 hours but less than 12 hours apart
5	Drift of buoys
6	Reserved
7	Missing

1.10 – *New entries in code table 0 02 034, "Drogue Type"*
Entries 0–5 are being introduced. The table would look like this:

Code figure	
0	Unspecified drogue
1	Holey sock
2	TRISTAR
3	Window shade
4	Parachute
5	Non Lagrangian sea anchor
6–30	Reserved (to be developed)
31	Missing value

2. REPRESENTATION OF ATMOSPHERICS

2.1 New Table B entries:

F X Y	*Description*	*Unit*	*Scale*	*Reference*	*Data width*
0 25 036	Atmospherics location method	Code table	0	0	4 bits
0 20 070	Minimum number of atmospherics	Numeric	0	0	7 bits
0 20 071	Accuracy of fix and rate of atmospherics	Code table	0	0	4 bits

2.2 New Code Tables:

Code Table 0 25 036

Code figure	Atmospherics location method
0	Network of several direction-finders operating on the same individual atmospherics
1	Network of several arrival-time stations operating on the same individual atmospherics
2-5	Reserved
6	Single station range bearing technique
7–14	Reserved
15	Missing value

Code Table 0 20 071

Code figure	Accuracy of fix and rate of atmospherics	
	Accuracy of fix (estimated error)	Repetition rate
0	No assessment	No assessment
1	Less than 50 km	Less than 1 per second
2	Between 50 and 200 km	Less than 1 per second
3	More than 200 km	Less than 1 per second
4	Less than 50 km	1 or more per second
5	Between 50 and 200 km	1 or more per second
6	More than 200 km	1 or more per second
7	Less than 50 km	Rate so rapid number cannot be counted

Code Table 0 20 071 (*continued*)

Code figure	Accuracy of fix and rate of atmospherics	
8	Between 50 and 200 km	Rate so rapid number cannot be counted
9	More than 200 km	Rate so rapid number cannot be counted
10–14	Reserved	
15	Missing value	

2.3 Add new entry 18 to existing BUFR Code Table:

Code Table 0 08 011 Meteorological feature

Code figure	Feature
18	Atmospherics
19	Reserved
etc.	

3. NEW DESCRIPTORS FOR PRECIPITATION DATA (CLASS 13)

The following BUFR Table B, Class 13 descriptors have incorrect reference values and are no longer in use:

F X Y	
0 13 011	Total precipitation/total water equivalent
0 13 012	Depth of fresh snow
0 13 013	Total snow depth
0 13 019	Total precipitation past 1 hour
0 13 020	Total precipitation past 3 hours
0 13 021	Total precipitation past 6 hours
0 13 022	Total precipitation past 12 hours
0 13 023	Total precipitation past 24 hours
0 13 052	Highest daily amount of precipitation

The following correct versions should be added to BUFR Table B, Class 13:

F X Y	*Element name*	*Unit*	*Scale*	*Reference value*	*Data width (bits)*
0 13 008	Total precipitation/total water equivalent	kg m^{-2}	1	-10	14
0 13 009	Depth of fresh snow	m	2	-200	12
0 13 010	Total snow depth	m	2	-200	16
0 13 024	Total precipitation past 1 hour	kg m^{-2}	1	-10	14
0 13 025	Total precipitation past 3 hours	kg m^{-2}	1	-10	14
0 13 026	Total precipitation past 6 hours	kg m^{-2}	1	-10	14
0 13 027	Total precipitation past 12 hours	kg m^{-2}	1	-10	14
0 13 028	Total precipitation past 24 hours	kg m^{-2}	1	-10	14
0 13 053	Highest daily amount of precipitation	kg m^{-2}	1	-10	14

Notes (1), (2), and (3) should be replaced with the following:

(1) A total precipitation value of -10 shall indicate a “trace”.

(2) A depth of fresh snow value of -100 shall indicate a fresh snow depth less than 0.5 cm. A depth of fresh snow value of -200 shall indicate “snow cover not continuous”.

(3) A total snow depth value of -100 shall indicate a total snow depth less than 0.5 cm. A total snow depth value of -200 shall indicate “snow cover not continuous”.

Add Note (7): Descriptors: 0 13 008 shall be used instead of 0 13 011
0 13 009 shall be used instead of 0 13 012
0 13 010 shall be used instead of 0 13 013
0 13 024 shall be used instead of 0 13 019
0 13 025 shall be used instead of 0 13 020
0 13 026 shall be used instead of 0 13 021
0 13 027 shall be used instead of 0 13 022
0 13 028 shall be used instead of 0 13 023
0 13 053 shall be used instead of 0 13 052.

4. THE FOLLOWING ENTRIES TO BE ADDED TO BUFR TABLE B SINCE THEY ARE USED IN CREX:

F X Y	*Element name*	*Unit*	*Reference scale*	*Data value*	*Width (bits)*
0 01 018	Short station or site name	CCITT IA5 0	0	0	40
0 01 062	Short ICAO location indicator	CCITT IA5 0	0	0	32
0 04 065	Short time increment	Minute	0	0	7
0 04 073	Short time period or displacement	Day	0	0	7
0 04 075	Short time period or displacement	Minute	0	0	7
0 08 006	Ozone vertical sounding significance	Flag table	0	0	9
0 08 031	Data category CREX table A	Numeric	0	0	8
0 08 035	Type of monitoring exercise	Code table	0	0	3
0 08 036	Type of centre or station performing monitoring	Code table	0	0	3
0 11 040	Maximum wind speed (mean wind)	m s^{-1}	1	0	12
0 12 031	Soil temperature at 50 cm below ground	K	1	0	12
0 13 060	Total accumulated precipitation	kg m^{-2}	1	-10	17
0 13 071	Upstream water level	m	2	0	14
0 13 072	Downstream water level	m	2	0	14
0 13 073	Maximum water level	m	2	0	14
0 13 080	Water pH	pH unit	1	0	10
0 13 081	Water conductivity	Siemens m^{-1}	3	0	14
0 13 082	Water temperature	K	1	0	12
0 13 083	Dissolved oxygen	kg m^{-3}	6	0	14
0 13 084	Turbidity	Lumen	0	0	14
0 14 051	Direct solar radiation integrated over last hour	J m^{-2}	-3	0	14
0 15 003	Measured ozone partial pressure (sounding)	Pascal	4	0	9
0 15 004	Ozone sounding correction factor	Numeric	3	0	11
0 15 005	Ozone p	DU	0	0	10
0 19 010	Method for tracing of the centre of synoptic feature	Code table	0	0	4
0 22 035	Tidal elevation with respect to local chart datum	m	2	0	14
0 22 036	Meteorological residual tidal elevation (surge or offset)	m	2	0	14

4.1 Add notes under Class 15:

NOTES:

(1) 0 15 003 is partial pressure of ozone, measured at the pressure level identified by 0 07 004.

(2) 0 15 004 (CF) is defined as :

CF = TOI/TOS

where TOI is the integrated ozone value obtained "simultaneously to a sounding" from a Dobson or Brewer spectrophotometer at the site or "nearby" and TOS is the total ozone obtained from the sounding. TOS is the sum of the integrated ozone below the lowest pressure level reached by the sounding and the estimate of the amount above. In the absence of any spectrophotometer measurement, CF = Missing value.

(3) 0 15 005 is the value obtained as the result of the vertical integration of the sounding values (0 15 003) measured below the lowest pressure level reached by the sonde, multiplied by 0 15 004.

(4) DU = Dobson Unit.

4.2 Add new Class 35:

Class 35 — Data monitoring information

Reference F X Y	*Element name*	*Unit*	*Scale*	*Reference value*	*Data width*
0 35 000	FM and regional code number	Code table	0	0	10
0 35 001	Time frame for monitoring	Code table	0	0	3
0 35 011	Number of reports actually received	Numeric	0	0	14
0 35 021	Bulletin being monitored (TTAAii)	Character	0	0	48
0 35 022	Bulletin being monitored (YYGGgg)	Character	0	0	48
0 35 030	Discrepancies in the availability of expected data	Code table	0	0	4
0 35 031	Qualifier on monitoring results	Code table	0	0	7
0 35 032	Cause of missing data	Code table	0	0	4
0 35 033	Observation and collection deficiencies	Code table	0	0	7
0 35 034	Statistical trends for availability of data (during the survey period(s))	Code table	0	0	3

4.3 Add parameters to Code Table 0 02 041

Code figure	
4–9	Reserved
10	Information based on the numerical weather prediction
11–62	Reserved

4.4 Change in Code Table 0 02 144:

Code figure	
0	Direct sun

Add Note: Entries 1 and 2 should not be used.

4.5 New entries were recommended for Code Table 0 02 146

Code figure	
8	On zenith haze
9	On direct sun through thin cloud, fog or haze

4.6 Add new Flag Table 0 08 006 Ozone vertical sounding significance

Bit number	
1	Surface
2	Standard level
3	Tropopause level
4	Prominent maximum level
5	Prominent minimum level
6	Minimum pressure level
7	Reserved
8	Level of undetermined significance
9	Missing value

4.7 Additional entries in Code Table 0 08 021 Time significance

Code figure	Description
23	Monitoring period
24	Agreed time limit for report reception
25	Nominal reporting time

4.8 New Code Tables

0 08 035	Type of monitoring exercise

Code figure	Description
0	Global
1	Regional
2	National
3	Special
4	Bilateral
5	Reserved
6	Reserved
7	Missing value

0 08 036 Type of centre or station performing monitoring

Code figure	Description
0	WMO Secretariat
1	WMO
2	RSMC
3	NMC
4	RTH
5	Observing site
6	Other
7	Missing value

0 19 010 Method for tracing of the centre of synoptic feature code figure

Code figure	Description
1	Minimum value of sea level pressure
2	Maximum value of 850 hPa relative vorticity
3–14	Reserved
15	Missing value

0 35 000 FM and regional code number

Code figure	Description
000–099	International FM codes
100–199	RA I codes
200–299	RA II codes
300–399	RA III codes
400–499	RA IV codes
500–599	RA V codes
600–699	RA VI codes
700–799	Antarctic codes
800–999	Reserved
1 000–1 022	Not used
1 023	Missing value

0 35 001 Time frame for monitoring

Code figure	Description
0	Real time
1	Near-real time
2	Non-real time
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Missing value

0 35 030 Discrepancies in the availability of expected data

Code figure	Description
0	No discrepancies
1	Non-compliance with standard and recommended practices and procedures including those of monitoring
2	Catalogues of meteorological bulletins not updated in a timely manner
3	Incorrect routeing directories
4	Lack of flexibility in the routeing arrangements
5	Deficiencies in the operation of GTS centres and circuits
6	Loss of data or delays in relaying data on the GTS
7	Routeing of data different from the routeing provided in the plan
8	Various malpractices
9–14	Reserved
15	Missing value

0 35 031 Qualifier on monitoring results

Code figure	Description
1	Sufficient and all of acceptable quality
2	Sufficient but partly of acceptable quality
3	Insufficient but all of acceptable quality
4	Insufficient and of unacceptable quality
5	Some messages not complete
6	Suspect or wrongly coded groups could not be interpreted confidently
7	Gross coding errors
8	Transmission sequential order not observed
9	Report completely garbled and thus discarded
10	Deficiencies identified and rectified
11	Deficiencies identified but not rectified
12	Defiencies not identified
13	Measuring errors
14	Mutual inconsistency
15	Temporal inconsistency
16	Forecast errror
17	Bias
18	Improve system of quality control
19	Expand training programmes
20–98	Reserved
99–122	Not used
123	Missing value

0 35 032 Cause of missing data

Code figure	Description
1	Data groups missing due to radio fading
2	Data groups missing due to outage of centre
3	Data groups missing due to outage of circuit
4	Non-implementation or maintenance of required RBSN density
5	Shortage of qualified staff to man stations
6	Lack of consumables
7	Instrument failure
8	Non-adherence to telecommuniction procedures
9	Some observing programmes ceased
10–14	Not used
15	Missing value

0 35 033 Observation and collection deficiency

Code figure	Description
1	No deficiency
2	Observations not made regularly
3	Observations not made at right time
4	Observations made but not disseminated
5	Observations made and sent to incorrect users
6	Collection not received
7	Collection transmitted late
8	Collection not transmitted
9	Difficulties in HF propagation and selection of suitable frequency
10	Difficulties in maintenance of communication equipment at remote stations
11	No alternative arrangement for routeing meteorological observation
12–99	Reserved
100–122	Not used
123	Missing value

0 35 034 Statistical trends for availability of data (during the survey period(s))

Code figure	Description
1	Slight improvement
2	Significant improvement
3	Most significant improvement
4	Steady
5	Decreasing
6	Efforts required to improve night-time observations
7	Missing value

4.9 Add Notes under table of Class 22:

(6) Descriptors 0 22 001, 0 22 002, 0 22 003; the direction given in these entries is the direction waves are coming from.
(7) Descriptor 0 22 004; the direction given in this entry is the direction towards which current is flowing.
(8) Wind waves and waves reporting standards:

Observation	*Speed*	*Direction*
No observation	Missing	Missing
Calm	0	0
Normal observation	>0	1–360
Speed only	>0	Missing
Direction only	Missing	1–360
"Light and variable"	>0	0

5. IMPROVE REGULATION FOR COMPRESSION METHOD OF CHARACTER ARRAYS AND BIT LENGTH CHARACTER

Change Regulation 94.6.3, Note (2) to read:

(2) ... (no change) ... :

(i) Values for each data element are grouped into sets, and sets shall be in the order defined by the data description; the first value in each set shall represent a minimum value for the set; for character data the first value in the set shall be set to all bits zero; however, if the character data values in all subsets are identical, the first value shall represent the character string; this value is termed ... (rest unchanged);

(ii) ... (no change) ...

(iii) ... (no change) ...

(iv) The local value shall be followed by a 6-bit quantity specifying the number of bits for each increment, or for character data, specifying the number of octets representing the character string. However, if the character data values in all subsets are identical sub-note (vii) shall apply.

(v) to (viii) (no change)

Change in Page I.2 - Bi - 34, Note (2), last sentence, as follows:

For character data, NBINC shall contain the number of octets occupied by the character element. However, if the character data in all subsets are identical NBINC=0.

Add a new NOTE (9) in page I.2 - Bi - 27, as follows:

(9) In the BUFR message, the bit length for "International Alphabet No. 5" is regarded as 8-bit, adding one bit "0" to the 7-bit of IA5 as the most significant bit.

Add a new NOTE (8) in page I.2 - Bi - 4, before the GRIB regulations, as follows:

(8) In the GRIB message, the bit length of "International Alphabet No. 5" is regarded as 8-bit, adding one bit "0" to the 7-bit of IA5 as the most significant bit.

ANNEX 2 TO RECOMMENDATION 6 (CBS-EXT.(98))

LIST OF UNITS FOR BUFR TABLE B AND CREX TABLE B AND C

1. NEW COMMON CODE TABLE C-6

Code figure	*Base SI units (1)*	*Conventional abbreviation*	*Abbreviation in IA5/ASCII (5)*	*Abbreviation in ITA2 (5)*	*Definition in base units (2)*
001	metre	m	m	M	
002	kilogram	kg	kg	KG	

Code figure	*Base SI units (1)*	*Conventional abbreviation*	*Abbreviation in IA5/ASCII (5)*	*Abbreviation in ITA2 (5)*	*Definition in base units (2)*
003	second	s	s	S	
004	ampere	A	A	A	
005	kelvin	K	K	K	
006	mole	mol	mol	MOL	
007	candela	cd	cd	CD	
	Supplementary SI Units (1)				
021	radian	rad	rad	RAD	
022	steradian	sr	sr	SR	
	Derived SI Units with special names (1)				
030	hertz	Hz	Hz	HZ	s^{-1}
031	newton	N	N	N	kg m s^{-2}
032	pascal	Pa	Pa	PAL	kg m^{-1} s^{-2}
033	joule	J	J	J	kg m^2 s^{-2}
034	watt	W	W	W	kg m^2 s^{-3}
035	coulomb	C	C	C	A s
036	volt	V	V	V	kg m^2 s^{-3} A^{-1}
037	farad	F	F	F	kg^{-1} m^{-2} s4 A^2
038	ohm	W	Ohm	OHM	kg m^2 s^{-3} A^{-2}
039	siemens	S	S	SIE	kg^{-1} m^{-2} s^3 A^2
040	weber	Wb	Wb	WB	kg m^2 s^{-2} A^{-1}
041	tesla	T	T	T	kg s^{-2} A^{-1}
042	henry	H	H	H	kg m^2 s^{-2} A^{-2}
060	degree Celsius	°C	Cel	CEL	K+273.15
070	lumen	lm	lm	LM	cd sr
071	lux	lx	lx	LX	cd sr m^{-2}
080	becquerel	Bq	Bq	BQ	s^{-1}
081	gray	Gy	Gy	GY	m^2 s^{-2}
082	sievert	Sv	Sv	SV	m^2 s^{-2}
	SI Unit prefixes (1) (3) (4)				
no	(yotta)	(Y)	(Y)	(Y)	
no	(zetta)	(Z)	(Z)	(Z)	
no	exa	E	E	E	
no	peta	P	P	PE	
no	tera	T	T	T	
no	giga	G	G	G	
no	mega	M	M	MA	
no	kilo	k	k	K	
no	hecto	h	h	H	
no	deca	da	da	DA	
no	deci	d	d	D	
no	centi	c	c	C	
no	milli	m	m	M	
no	micro	m	u	U	
no	nano	n	n	N	
no	pico	p	p	P	
no	femto	f	f	F	
no	atto	a	a	A	
no	(zepto)	(z)	(z)	?	
no	(yocto)	(y)	(y)	?	

Code figure	*Base SI units (1)*	*Conventional abbreviation*	*Abbreviation in IA5/ASCII (5)*	*Abbreviation in ITA2 (5)*	*Definition in base units (2)*
	Other, non-SI, units recognized by CGPM (4)				
110	degree (angle)	º	deg	DEG	
111	minute (angle)	‘	‘	MNT	
112	second (angle)	"	"	SEC	
120	litre	l or L	l or L	L	
130	minute (time)	min	min	MIN	
131	hour	h	h	HR	
132	day	d	d	D	
150	tonne	t	t	TNE	
160	electron volt	eV	eV	EV	
161	atomic mass unit	u	u	U	
170	astronomic unit	AU	AU	ASU	
171	parsec	pc	pc	PRS	
	Non-SI units tolerated because of widespread use				
200	nautical mile				
201	knot	kt	kt	KT	
210	decibel (6)	dB	dB	DB	
220	hectare	ha	ha	HAR	
230	week				
231	year	a	a	ANN	
	Other units as used by WMO (8)				
300	per cent	%	%	PERCENT	
301	parts per thousand	0/00	0/00	PERTHOU	
310	eighths of cloud	okta	okta	OKTA	
320	degrees true	°	deg	DEG	
321	degrees per second	degree/s	deg/s	DEG/S	
350	degrees Celsius **(9)**	°C	C	C	
351	degrees Celsius per metre	°C/m	C/m	C/M	
352	degrees Celsius per 100 metres	°C/100 m	C/100 m	C/100 M	
360	Dobson Unit	DU	DU	DU	
430	month	mon	mon	MON	
441	per second (same as hertz)	s^{-1}	/s	/S	
442	per second squared	s^{-2}	s^{-2}		
501	knots per 1 000 metres	kt/1000 m	kt/km	KT/KM	
510	foot	ft	ft	FT	
511	inch	in	in	IN	
520	decipascals per second (microbar per second)	dPa s^{-1}	dPa/s	DPAL/S	
521	centibars per second	cb s^{-1}	cb/s	CB/S	
522	centibars per 12 hours	cb/12 h	cb/12 h	CB/12 HR	
523	dekapascal	daPa	daPa	DAPAL	
530	hectopascal	hPa	hPa	HPAL	
531	hectopascals per second	hPa s^{-1}	hPa/s	HPAL/S	
532	hectopascals per hour	hPa h^{-1}	hPa/h	HPAL/HR	
533	hectopascals per 3 hours	hPa/3 h	hPa/3 h	HPAL/3 HR	
535	nanobar = hPa 10^{-6}	nbar	nbar	NBAR	
620	grams per kilogram	g kg^{-1}	g/kg	G/KG	
621	grams per kilogram per second	g kg^{-1} s^{-1}	g kg^{-1} s^{-1}		

Code figure	*Base SI units (1)*	*Conventional abbreviation*	*Abbreviation in IA5/ASCII (5)*	*Abbreviation in ITA2 (5)*	*Definition in base units (2)*
622	kilograms per kilogram	kg kg^{-1}	kg/kg	KG/KG	
623	kilograms per kilogram per second	kg kg^{-1} s^{-1}	kg kg^{-1} s^{-1}		
624	kilograms per square metre	kg m^{-2}	kg m^{-2}		
630	acceleration due to gravity	g	g		
631	geopotential metre	gpm	gpm		
710	millimetre	mm	mm	MM	
711	millimetres per second	mm s^{-1}	mm/s	MM/S	
712	millimetres per hour	mm h^{-1}	mm/h	MM/HR	
713	millimetres to the sixth power per cubic metre	mm^6 m^{-3}	mm^6 m^{-3}		
715	centimetre	cm	cm	CM	
716	centimetres per second	cm s^{-1}	cm/s	CM/S	
717	centimetres per hour	cm h^{-1}	cm/h	CM/HR	
720	decimetre	dm	dm	DM	
731	metres per second	m s^{-1}	m/s	M/S	
732	metres per second per metre	m s^{-1}/m	m s^{-1}/m		
733	metres per second per 1 000 m	m s^{-1}/1000 m	m s^{-1}/km		
734	square metres	m^2	m^2	M2	
735	square metres per second	m^2 s^{-1}	m^2/s	M2/S	
740	kilometre	km	km	KM	
741	kilometres per hour	km h^{-1}	km/h	KM/HR	
742	kilometres per day	km/d	km/d	KM/D	
no	per metre	m^{-1}	m-1	/M	
750	becquerels per litre	Bq l^{-1}	Bq/l	BQ/L	
751	becquerels per square metre	Bq m^{-2}	Bq m^{-2}	BQ/M2	
752	becquerels per cubic metre	Bq m^{-3}	Bq m^{-3}	BQ/M3	
753	millisievert	mSv	mSv	MSV	

NOTES:

(1) The international system of units, Système International, SI, was established by the 11th Conférence Générale des Poids et Mesures in 1960, and extended at the 1980 conference. There are 7 Base Units, 2 dimensionless Supplementary Units and a set of prefixes for decimal scaling. These may be combined to give compound units. Some compound units have special names, and are called Derived Units.

(2) When documenting compound SI units, each symbol for each base unit has been separated from the others by a space. There is no space between the unit and any prefix or exponent. Any prefix establishes a new unit to which any exponent applies (e.g. $km^2 = (km)^2 = m^6$ not $k(m^2) = m^5$). Prefixes must be in the case specified. The full name of the unit must not start with an upper case letter. If the solidus (/) is used, there must be only one. There is no space before or after it.

(3) Prefixes beyond exa and atto have been proposed but not yet adopted. Use of the prefixes hecto, deka, deci and centi is discouraged.

(4) Prefixes generally should not be used with units having non-decimal multiples and sub-multiples, such as units of time and angle, or with knots and nautical miles.

(5) Non-WMO abbreviations with limited character sets taken from ISO 2955-1983. Other abbreviations try to be consistent with this.

(6) The decibel is one tenth of a bel, which is the decimal logarithm of a ratio of two powers. Frequently, suffixes are supplied to indicate information about one of the quantities in the ratio, such as dB(mW), dBm, dBW, dBmW, dB(uV/m). It is recommended that only dB is used, with the full meaning of the ratio explained, including reference levels.

(7) ISO 31: Part 11 recommends that lg is used for the decimal logarithm as well as $\log_{10}$

(8) This list consists of the units not mentioned previously that occur in existing WMO *Manuals*.

(9) The abbreviation for degrees Celsius proposed for WMO use, C, could be confused with Coulombs. In this case, Amperes second should be used instead.

(10) Dobson Unit = DU. One Dobson Unit corresponds to a layer of 0.01 mm of pure ozone, if the whole column of atmosphere were compressed at P=1013 hPa and T = 10°C.

2. NEW COMMON CODE TABLE C-8 SATELLITE INSTRUMENTS

Addition in BUFR:

0 02 019	Satellite Instrument	Code table	0	0	11

Common Code Table C-8 Satellite Instruments

Code table 0 02 019 in BUFR

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
1	ASI	Lidar	Laser cornercube reflectors	
10	BNSC	Radiometer	AATSR	Advanced along track scanning radiometer
11	BNSC	Radiometer	ATSR	Along track scanning radiometer
12	BNSC	Radiometer	ATSR-2	Along track scanning radiometer -2
13	BNSC	Radiometer	MWR	Microwave radiometer
30	CNES	Communications	ARGOS	
40	CNES	Lidar	Laser reflectors	
41	CNES	Lidar	DORIS	DORIS
42	CNES	Lidar	DORIS-NG	Doppler orbitography and radio positioning Integrated by satellite-NG
45	CNES	Radar	POSEIDON	Positionning ocean solid Earth ice dynamics orbiting navigator
46	CNES	Radar	POSEIDON-2	Positioning ocean solid Earth ice dynamics orbiting navigator
47	CNES	Radar	SSALT	Single frequency solid state radar altimeter
48	CNES	Radar	SSALT-2	Dual frequency solid state radar altimeter
50	CNES	Radiometer	ATSR/M	ATSR/M
51	CNES	Radiometer	HRG	
52	CNES	Radiometer	HRV	High-resolution visible
53	CNES	Radiometer	HRVIR	High-resolution visible and infrared
54	CNES	Radiometer	ScaRaB/MV1	Scanner for Earth's radiation budget
55	CNES	Radiometer	POLDER	POLDER
60	CNES	Spectrometer	VEGETATION	VEGETATION
61	CNES	Spectrometer	WINDII	WINDII
73	CNES	TBD	UGT	UGT
80	CSA	Communications	RADARSAT DTT	
81	CSA	Communications	RADARSAT TTC	
85	CSA	Radar	SAR (CSA)	Syntetic aperture radar (CSA)
90	CSA	Radiometer	MOPITT	Measurements of pollution in the troposphere
100	DARA	Radiometer	AMAS	Advanced millimetre atmospheric sounder
101	DARA	Radiometer	MOMS-2P	Modular optoelectronic multispectral scanner
102	DARA	Radiometer	CHAMP GPS sounder	GPS turborogue space receiver (TRSR)
116	DARA	Magnetometer	CHAMP gravity package (Accelerometer+GPS)	STAR accelerometer
117	DARA	Magnetometer	CHAMP magnetometry package (1 scalar+ 2 vector magnetometer)	Overhauser magnetometer (OVM)and fluxgate magnetometer (FGM)
118	DARA	Lidar	PRARE	Precise range and rate equipment
120	ESA	Communications	ENVISAT Comms	Communications package on ENVISAT
121	ESA	Communications	ERS Comms	Communication package for ERS
130	ESA	Lidar	ALADIN	Atmospheric laser doppler instrument
131	ESA	Lidar	ATLID	Atmospheric lidar
140	ESA	Radar	AMI/SAR/image	Active microwave instrumentation image mode
141	ESA	Radar	AMI/SAR/wave	Active microwave instrumentation wave mode
142	ESA	Radar	AMI/scatterometer	Active microwave instrumentation wind mode
143	ESA	Radar	ASAR	ASAR
144	ESA	Radar	ASAR (image mode)	Advanced syntetic aperture radar (image mode)

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
145	ESA	Radar	ASAR (wave mode)	Advanced syntetic aperture radar (Wave mode)
146	ESA	Radar	CPR	Cloud radar
147	ESA	Radar	RA-2/MWR	Radar altimeter - 2
148	ESA	Radar	RA/MWR	Radar altimeter
149	ESA	Radar	RADAR	Rain radar
150	ESA	Radar	SCATTEROMETER	Scatterometer
160	ESA	Radiometer	MIMR	Multi-frequency imaging microwave radiometer
161	ESA	Radiometer	MIPAS	Michelson interferometric passive atmosphere sounder
162	ESA	Radiometer	MWR-2	Microwave radiometer-2
163	ESA	Radiometer	SOPRANO	Sub-millimetre observation of processes in the absorption noteworthy for ozone
164	ESA	Radiometer	PRISM	Process research by an imaging space mission
170	ESA	Spectrometer	GOME	Global ozone monitoring experiment
171	ESA	Spectrometer	GOMI	Global ozone monitoring instrument
172	ESA	Spectrometer	GOMOS	Global ozone monitoring by occultation of stars
173	ESA	Spectrometer	MASTER	MASTER
174	ESA	Spectrometer	MERIS	Medium resolution imaging spectrometer
175	ESA	Spectrometer	SCIAMACHY	Scanning imaging absorption spectrometer for atmospheric cartography
180	EUMETSAT	Communications	MCP	Meteorological communications package (MCP)
181	EUMETSAT	Communications	METEOSAT Comms	Communications package for METEOSAT
182	EUMETSAT	Communications	MSG Comms	Communications package for MSG
190	EUMETSAT	Radar	ASCAT	Avanced scatterometer
200	EUMETSAT	Radiometer	GERB	Geostationary Earth radiation budget
201	EUMETSAT	Radiometer	GPS-S	GPS sounder
202	EUMETSAT	Radiometer	GRAS	GNSS receiver for atmospheric sounding
203	EUMETSAT	Radiometer	MHS	Microwave humidity sounder
204	EUMETSAT	Radiometer	MTS	Microwave temperature sounder
205	EUMETSAT	Radiometer	MVIRI	METEOSAT visible and infrared imager
206	EUMETSAT	Radiometer	OMI	Ozone monitoring instrument
207	EUMETSAT	Radiometer	SEVIRI	Spinning enhanced visible and infrared imager
208	EUMETSAT	Radiometer	VIRI	
220	EUMETSAT	Spectrometer	GOME-2	Global ozone monitoring experiment - 2
221	EUMETSAT	Spectrometer	IASI	Infrared atmospheric sounding interferometer
240	INPE	Communications	DCP	Data-collection platform transponder
245	INPE	Radiometer	CCD	High-resolution CCD camera
246	INPE	Radiometer	HSB	Humidity sounder/Brazil
247	INPE	Radiometer	IR multi-scanner	
248	INPE	Radiometer	OBA	Observador Brasileiro da Amaztnia
249	INPE	Radiometer	VWFI	
250	INPE	Radiometer	WFI	Wide field imager
255	INPE	Spectrometer	IRMSS	Infrared multispectral scanner
260	ISRO	Communications	BSS & FSS transponders	
261	ISRO	Communications	DRT-S&R	
262	ISRO	Communications	INSAT Comms	Communications package for INSAT
268	ISRO	Radiometer	HR-PAN	High-resolution panchromatic camera
269	ISRO	Radiometer	MSMR	Multifrequency scanning microwave radiometer
270	ISRO	Radiometer	VHRR	
271	ISRO	Radiometer	WiFS	Wide field sensor
272	ISRO	Radiometer	WiFS'	Wide field sensor on IRS-P3
275	ISRO	Spectro-radiometer	AWiFS	Advanced wide field sensor
276	ISRO	Spectro-radiometer	LISS-I	Linear imaging self scanner – I
277	ISRO	Spectro-radiometer	LISS-II	Linear imaging self scanner – II

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
278	ISRO	Spectro-radiometer	LISS-III	Linear imaging self scanner – III
279	ISRO	Spectro-radiometer	LISS-IV	Linear imaging self scanner – IV
284	ISRO	Spectro-radiometer	PAN	Panchromatic sensor
285	ISRO	Spectrometer	MOS	Modular opto-electronic scanner
286	ISRO	Spectrometer	OCM	Ocean colour monitor
290	JMA	Communications	MTSAT Comms	Communications package for MTSAT
295	JMA	Radiometer	IMAGER/MTSAT	Imager/MTSAT
296	JMA	Radiometer	VISSR	Visible and infrared spin scan radiometer
300	NASA	Lidar	GLAS	Geoscience laser altimeter system
301	NASA	Lidar	LRA	Laser retroreflector array
302	NASA	Lidar	VCL	Vegetation canopy lidar
310	NASA	Radar	DFA	Dual frequency radar altimeter
311	NASA	Radar	LightSAR	Light synthetic aperture radar
312	NASA	Radar	NSCAT	NASA scatterometer
313	NASA	Radar	SeaWinds	ADEOS II — NASA scatterometer
330	NASA	Radiometer	ACRIM	Active cavity radiometer irradiance monitor
331	NASA	Radiometer	ACRIM II	Active cavity radiometer irradiance monitor II
335	NASA	Radiometer	AHiRDLS	Advanced high-resolution dynamics limb sounder
336	NASA	Radiometer	ALI	Advanced land imager
337	NASA	Radiometer	AMLS	Advanced microwave limb sounder
340	NASA	Radiometer	AMR	Altimetry microwave radiometer
341	NASA	Radiometer	AMR + SSALT	
345	NASA	Radiometer	AMSR/E	Advanced microwave scanning radiometer/E
346	NASA	Radiometer	AMSU	Advanced microwave sounding unit
347	NASA	Radiometer	ASTER	Advanced spaceborne thermal emission and reflection radiometer
348	NASA	Radiometer	CERES	Cloud and the Earth's radiant energy system
349	NASA	Radiometer	EOSP	Earth observing and scanning polarimeter
350	NASA	Radiometer	ETM	Enhanced thematic mapper +
351	NASA	Radiometer	GPSDR	GPS demonstration receiver
352	NASA	Radiometer	GRACE	Gravity recovery and climate experiment
353	NASA	Radiometer	HiRDLS	High-resolution dynamics limb sounder
354	NASA	Radiometer	HRDI	High-resolution doppler imager
355	NASA	Radiometer	LATI	Landsat advanced technology instrument
356	NASA	Radiometer	LIS	Lightning imaging sensor
357	NASA	Radiometer	NMP Vis/IR land imager	Advanced land imaging
358	NASA	Radiometer	PEM	Particle environment monitor
359	NASA	Radiometer	SeaWiFS	Sea-viewing wide field-of-view sensor
360	NASA	Radiometer	SUSIM	Solar ultraviolet irradiance monitor
361	NASA	Radiometer	T/P GDR	Topex poseidon geophysical data record
362	NASA	Radiometer	T/P IGDR	Topex poseidon integrated geophysical data record
365	NASA	Radiometer	TMI	TRMM microwave imager
366	NASA	Radiometer	TMR	TOPEX microwave radiometer
367	NASA	Radiometer	TPFO GDR	TPFO geophysical data record
368	NASA	Radiometer	TPFO IGDR	TOPEX-POSEIDON interim geophysical data record
375	NASA	Radiometer	VIRS	Visible infrared scanner
376	NASA	Radiometer	POLDER II	Polarization and directionality of the Earth's reflectance – II
380	NASA	Spectro-radiometer	AMISR	Advanced multi-angle imaging spectroradiometer
381	NASA	Spectro-radiometer	AMODIS	Advanced moderate-resolution imaging spectroradiometer
382	NASA	Spectro-radiometer	CLAES	Cryogenic limb array etalon spectrometer
383	NASA	Spectro-radiometer	HALOE	Halogen occultation experiment

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
384	NASA	Spectro-radiometer	ISAMS	Improved stratospheric and mesospheric sounder
385	NASA	Spectro-radiometer	MISR	Multi-angle imaging spectroradiometer
386	NASA	Spectro-radiometer	MLS	Microwave limb sounder
387	NASA	Spectro-radiometer	MLS (EOS-CHEM)	Microwave limb sounder (EOS-CHEM)
388	NASA	Spectro-radiometer	MLS (UARS)	Microwave limb sounder (UARS)
389	NASA	Spectro-radiometer	MODIS	Moderate-resolution imaging spectroradiometer
400	NASA	Spectro-radiometer	SAGE II	Stratospheric aerosol and gas experiment-II
401	NASA	Spectro-radiometer	SAGE III	Stratospheric aerosol and gas experiment-III
420	NASA	Spectrometer	AIRS	Atmospheric infrared sounder
421	NASA	Spectrometer	AIRS + AMSU	Atmospheric infrared sounder + advanced microwave sounding unit
424	NASA	Spectrometer	ATES	Advanced troposhperic emission spectrometer
426	NASA	Spectrometer	SOLSTICE	Solar stellar irradiance comparison experiment
427	NASA	Spectrometer	SOLSTICE II	Solar stellar irradiance comparison experiment – II
430	NASA	Spectrometer	TES	Troposhperic emission spectrometer
431	NASA	Spectrometer	TOMS	Total ozone mapping spectrometer
450	NASDA	Communications	ADEOS Comms	Communications package for ADEOS
451	NASDA	Communications	DCS (NASDA)	Data-collection system (NASDA)
452	NASDA	Communications	DPC	
453	NASDA	Communications	GMS Comms	Communications package on GMS
454	NASDA	Communications	JERS-1 Comms	Communications package for JERS-1
460	NASDA	Lidar	RIS	Retroreflector in space
461	NASDA	Radar	PR	Precipitation radar
462	NASDA	Radar	SAR	Synthetic aperture radar
463	NASDA	Radar	VSAR	Synthetic aperture radar
470	NASDA	Radar	PALSAR	Phase array type L-band synthetic aperture radar
480	NASDA	Radiometer	ALOS/PRISM	Panchromatic remote-sensing instrument for stereo mapping
481	NASDA	Radiometer	AMSR	Advanced microwave scanning radiometer
482	NASDA	Radiometer	AVNIR	Advanced visible and near infrared radiometer
483	NASDA	Radiometer	AVNIR-2	Advanced visible and near infrared radiometer type 2
484	NASDA	Radiometer	GLI	Global imager
485	NASDA	Radiometer	MESSR	Multispectral electronic self scanning radiometer
486	NASDA	Radiometer	MSR	Microwave scanning radiometer
487	NASDA	Radiometer	OCTS	Ocean color and temperature scanner
488	NASDA	Radiometer	OPS	Optical sensor
490	NASDA	Radiometer	VTIR	Visible and thermal infrared radiometer
510	NASDA	Spectrometer	ILAS	Improved limb atmospheric spectrometer
511	NASDA	Spectrometer	ILAS-II	Improved limb atmospheric spectrometer
512	NASDA	Spectrometer	IMG	Inferometric monitor of geenhouse gases
513	NASDA	Spectrometer	ODUS	Ozone dynamics ultraviolet spectrometer
514	NASDA	Spectrometer	SEM (NASDA)	Space environment monitor (NASDA)
540	NOAA	Communications	DCS (NOAA)	Data-collection system (NOAA)
541	NOAA	Communications	GOES Comms	Communications package on GOES
542	NOAA	Communications	LANDSAT Comms	Communications package for LANDSAT
543	NOAA	Communications	NOAA Comms	Communications package for NOAA
544	NOAA	Communications	S&R (GOES)	Search and rescue
545	NOAA	Communications	S&R (NOAA)	Search and rescue
546	NOAA	Communications	WEFAX	Weather facsimile
560	NOAA	Radiometer	(HIRS/2 + SBUV/2)	High-resolution infrared sounder/2 + solar Backscattter ultraviolet instrument/2
561	NOAA	Radiometer	(HIRS/3 + SBUV/2)	High-resolution infrared sounder/3 + solar Backscattter ultraviolet instrument/2
570	NOAA	Radiometer	AMSU-A	Advanced microwave sounding unit-A
571	NOAA	Radiometer	AMSU-A1-1	Advanced microwave sounding unit-A1-1

572	NOAA	Radiometer	AMSU-A1-2	Advanced microwave sounding unit-A1-2
573	NOAA	Radiometer	AMSU-A2	Advanced microwave sounding unit-A2
574	NOAA	Radiometer	AMSU-B	Advanced microwave sounding unit-B
580	NOAA	Radiometer	ATOVS (HIRS/3 + AMSU + AVHRR/3)	Advanced TIROS operational vertical sounder
590	NOAA	Radiometer	AVHRR/2	Advanced very high-resolution radiometer/2
591	NOAA	Radiometer	AVHRR/3	Advanced very high-resolution radiometer/3
592	NOAA	Radiometer	AVHRR/4	Advanced very high-resolution radiometer/4
600	NOAA	Radiometer	ERBE	Earth's radiation budget experiment
601	NOAA	Radiometer	ETM+	Enhanced thematic mapper
605	NOAA	Radiometer	HIRS/2	High-resolution infrared sounder/2
606	NOAA	Radiometer	HIRS/3	High-resolution infrared sounder/3
607	NOAA	Radiometer	HIRS/4	High-resolution infrared sounder/4
615	NOAA	Radiometer	IMAGER	Imager
616	NOAA	Radiometer	IMAGER/NP	Imager/NPOESS
620	NOAA	Radiometer	IRS/NP	Infrared sounder/NPOESS
621	NOAA	Radiometer	MICROWAVE/NP	Microwave/NPOESS
622	NOAA	Radiometer	MSS	Multispectral scanning system
623	NOAA	Radiometer	MSU	Microwave sounding unit
624	NOAA	Radiometer	SBUV/2	Solar backscattter ultraviolet instrument/2
625	NOAA	Radiometer	SBUV/3	Solar backscattter ultraviolet instrument/3
626	NOAA	Radiometer	SOUNDER	SOUNDER
627	NOAA	Radiometer	SSU	Stratospheric sounding unit
628	NOAA	Radiometer	TM	Thematic mapper
629	NOAA	Radiometer	TOVS (HIRS/2 + MSU + SSU)	TIROS operational vertical sounder
630	NOAA	Radiometer	VAS	VISSR atmospheric sounder
645	NOAA	Spectrometer	SEM	Space environment monitor
650	NRSCC	Radiometer	MVIRSR (10 channel)	Multispectral visible and infrared scan radiometer
651	NRSCC	Radiometer	MVIRSR (3 channel)	Multispectral visible and infrared scan radiometer
652	NRSCC	Radiometer	MVIRSR (5 channel)	Multispectral visible and infrared scan radiometer
670	NSAU	Radar	RLSBO	Side looking microwave radar
671	NSAU	Radar	RLSBO with scatterometer	Side looking microwave radar
672	NSAU	Radar	SAR (NSAU)	Syntetic aperture radar (NSAU)
680	NSAU	Radiometer	MSU-EU	Multispectral radiometer with high resolution
681	NSAU	Radiometer	MSU-UM	Visible multispectral radiometer
682	NSAU	Radiometer	RM-08	Imaging microwave radiometer
683	NSAU	Radiometer	SU-UMS	Stereo radiometer with high resolution
684	NSAU	Radiometer	SU-VR	Visible radiometer with high resolution
685	NSAU	Radiometer	TRASSER	
692	NSAU	Spectro-radiometer	Spectro-radiometer medium resolution	
693	NSAU	Spectro-radiometer	TIR spectro-radiometer	
700	RSA	Communications	KONDOR-2	Data-collection and transmission system
701	RSA	Communications	BRK	
710	RSA	Lidar	ALISSA	Backscatter lidar
711	RSA	Lidar	Balkan-1	
712	RSA	Lidar	Balkan-2 lidar	
715	RSA	Lidar	MK-4	
716	RSA	Lidar	MK-4M	
730	RSA	Radar	Greben	Radar altimeter
731	RSA	Radar	SAR-10	Syntetic aperture radar
732	RSA	Radar	SAR-3	Syntetic aperture radar
733	RSA	Radar	SAR-70	Syntetic aperture radar
740	RSA	Radar	SLR-3	Side looking radar

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
745	RSA	Radar	Travers SAR	
750	RSA	Radiometer	174-K	Temperature and humidity profiler
751	RSA	Radiometer	BTVK	Scanning television radiometer
752	RSA	Radiometer	Chaika	Scanning infrared radiometer
753	RSA	Radiometer	DELTA-2	Multispectral microwave scanner
755	RSA	Radiometer	IKAR-D	Multispectral microwave scanner
756	RSA	Radiometer	IKAR-N	Multispectral microwave scanner
757	RSA	Radiometer	IKAR-P	Multispectral microwave scanner
760	RSA	Radiometer	ISP	
761	RSA	Radiometer	KFA-1000	Photographic camera
762	RSA	Radiometer	KFA-200	Photographic camera
763	RSA	Radiometer	KFA-3000	Photographic camera
770	RSA	Radiometer	Klimat	Scanning infrared radiometer
771	RSA	Radiometer	Klimat-2	Scanning infrared radiometer
775	RSA	Radiometer	MIRAS	
776	RSA	Radiometer	MIVZA	
777	RSA	Radiometer	MIVZA-M	Microwave scanning radiometer
780	RSA	Radiometer	MR-2000	
781	RSA	Radiometer	MR-2000M	
785	RSA	Radiometer	MR-900	Scanning telephotometer
786	RSA	Radiometer	MR-900B	Scanning visual band telephotometer
790	RSA	Radiometer	MSU-E	Multispectral high-resolution electronic scanner
791	RSA	Radiometer	MSU-E1	Multispectral high-resolution electronic scanner
792	RSA	Radiometer	MSU-E2	Multispectral high-resolution electronic scanner
793	RSA	Radiometer	MSU-M	
794	RSA	Radiometer	MSU-S	Multispectral medium resolution scanner
795	RSA	Radiometer	MSU-SK	Multispectral medium resolution conical scanner
796	RSA	Radiometer	MSU-V	Multispectral high-resolution conical scanner
810	RSA	Radiometer	MTZA	Scanning microwave radiometer
811	RSA	Radiometer	MVZA	
815	RSA	Radiometer	MZOAS	Scanning microwave radiometer
820	RSA	Radiometer	R-225	Single channel microwave radiometer
821	RSA	Radiometer	R-400	
822	RSA	Radiometer	R-600	Single channel microwave radiometer
830	RSA	Radiometer	RMS	Radiation measurement system
831	RSA	Radiometer	Scanning IR radiometer	
832	RSA	Radiometer	Scanning microwave radiometer 5–120 GHz	Scanning microwave radiometer
835	RSA	Radiometer	TV camera	
836	RSA	Radiometer	SILVA	
840	RSA	Spectro-radiometer	SROSMO	Spectroradiometer for ocean monitoring
850	RSA	Spectrometer	BUFS-2	Backscatter spectrometer/2
851	RSA	Spectrometer	BUFS-4	Backscatter spectrometer/4
855	RSA	Spectrometer	ISTOK-1	Infrared spectrometer
856	RSA	Spectrometer	SFM-2	Spectrometer to measure direct solar radiation
857	RSA	Spectrometer	DOPI	
858	RSA	Spectrometer	KGI-4	
859	RSA	Spectrometer	Ozon-M	
860	RSA	Spectrometer	RMK-2	
870	RSA	TBD	BNR (280k)	
871	RSA	TBD	BRIZ	
875	RSA	TBD	EFO-2	
877	RSA	TBD	Pheniks	
878	RSA	TBD	Priroda-5	
900	US DoD	Radiometer	MAXIE	Magnetospheric atmospheric X-ray imaging experiment
901	US DoD	Radiometer	OLS	Operational linescan system

Code	*Agency*	*Type*	*Instrument short name*	*Instrument long name*
905	US DoD	Radiometer	SSM/I	Mission sensor microwave imager
906	US DoD	Radiometer	SSM/T-1	Mission sensor microwave temperature sounder
907	US DoD	Radiometer	SSM/T-2	Mission sensor microwave water vapor sounder
908	US DoD	Radiometer	SSMIS	Mission sensor microwave imager sounder
910	US DoD	Radiometer	SXI	Solar X-ray imager
930	US DoD	Spectrometer	EHIC	Energetic heavy ion composition experiment
931	US DoD	Spectrometer	X-ray astronomy payload	
932–999		Reserved		
1000–2046		Reserved for long-term future use		(for BUFR only)
2047		Missing value		(for BUFR only)

ANNEX 3 TO RECOMMENDATION 6 (CBS-EXT.(98))

AMENDMENTS TO ALPHANUMERIC CODES AND RELATED TABLES

1. Amendment to FM 12-XI SYNOP, FM 13-XI SHIP and FM 14-XI SYNOP MOBIL regulations

Amend regulation 12.2.6.1 to read as follows.

12.2.6.1 This group shall always be included in an observation by a manually-operated station after a period of closure or at start up, when past weather conditions for the period applicable to the report are unknown, and shall take the form 7ww// (with i_x = 1), even if ww = 00–03. Otherwise it shall only be included if present or past weather phenomena of significance, or both, were observed. W_1W2_2 = // shall indicate that previous conditions are unknown. This regulation shall also apply to automatic reporting stations with the facility to report present and past weather. Where a single past weather form is recognized it shall take the form of $7wwW_1$/.

2. Additions to FM 32-IX PILOT, FM 33-IX PILOT SHIP and FM 34-IX PILOT MOBIL

2.1 In Part A, add the following after SECTION 3:

SECTION 5	51515	
	52525	Code groups to be developed regionally
	.....	
	59595	

NOTE: Identifier 55555 should not be used in Section 5.

SECTION 6	61616	
	62626	Code groups to be developed nationally
	.....	
	69696	

NOTE: Identifier 66666 should not be used in Section 6.

2.2 In Part C, add the following after SECTION 3:

SECTION 5	51515	
	52525	Code groups to be developed regionally
	.....	
	59595	

NOTE: Identifier 55555 should not be used in Section 5.

SECTION 6	61616	
	62626	Code groups to be developed nationally
	.....	
	69696	

NOTE: Identifier 66666 should not be used in Section 5.

3. Additions to FM 35-X Ext. TEMP, FM 36-X Ext. TEMP SHIP, FM 37-X Ext. TEMP DROP and FM 38-X Ext. TEMP MOBIL

3.1 In Part A, add the following after SECTION 4:

SECTION 9	51515	
	52525	Code groups to be developed regionally
	.....	
	59595	
SECTION 10	61616	
	62626	Code groups to be developed nationally
	.....	
	69696	

NOTE: Identifier 66666 should not be used in Section 10.

3.2 In Part C, add the following after SECTION 4:

SECTION 9	51515	
	52525	Code groups to be developed regionally
	.....	
	59595	
SECTION 10	61616	
	62626	Code groups to be developed nationally
	.....	
	69696	

NOTE: Identifier 66666 should not be used in Section 10.

3.3 SECTION 7 shall be included in all PARTs of the TEMP report. It shall be added to PART A, C and D.

4. Add the following regulations:

4.1 In FM 32-IX PILOT, FM 33-IX PILOT SHIP and FM 34-IX PILOT MOBIL:

32.3.1.5 Missing data

32.3.1.5.1 If altitude is given in geopotential units in Parts B and D, a layer for which data are missing shall be indicated by reporting the boundary levels of the layer and a level in between with a height value somewhere in between the boundary heights and a group ddfff of solidi (/////) to indicate the layer of missing data, provided that the layer is at least 1 500 geopotential metres thick. The boundary levels are the levels closest to the bottom and the top of the layer for which the observed data are available. The boundary levels are not required to meet "significant level" criteria. For example:

9226/ 27025 28030
9329/ ///// 29035

where 28030 and 29035 are the boundary level winds in 7 800 and 11 700 gpm altitude. The fictitious altitude 9 600 gpm together with the group of solidi indicates the layer for which data are missing.

32.3.1.5.2 If altitude is given in pressure units in Parts B and D, a layer for which data are missing shall be indicated by reporting the boundary levels of the layer and a level of solidi (/////) to indicate the layer of missing data, provided that the layer is at least 50 hPa thick. The boundary levels are the levels closest to the bottom and the top of the layer for which the observed data are available. The boundary levels are not required to meet "significant level" criteria. The boundary levels and the missing data level groups will be identified by appropriate nn numbers. For example:

$33P_3P_3P_3 \quad d_3d_3f_3f_3f_3$
44/// /////
$55P_5P_5P_5 \quad d_5d_5f_5f_5f_5$

where the levels 33 and 55 are the boundary levels and 44 indicates the layer for which data are missing.

4.2 FM 35-X Ext. TEMP, FM 36-X Ext. TEMP SHIP, FM 37-X Ext. TEMP DROP and FM 38-X Ext. TEMP MOBIL

Add a new regulation number 35.3.2.1 in front of the second line of present regulation 35.3.2, then add new regulation:

35.3.2.2 In Parts B and D, a layer for which data are missing shall be indicated by reporting the boundary levels of the layer and a level of solidi (/////) to indicate the layer of missing data, provided that the layer is at least 50 hPa thick. The boundary levels are the levels closest to the bottom and the top of the layer for which the observed data are available. The boundary levels are not required to meet "significant level" criteria. The boundary levels and the missing data level groups will be identified by appropriate nn numbers. For example:

$33P_3P_3P_3 \quad d_3d_3f_3f_3f_3$
44/// /////
$55P_5P_5P_5 \quad d_5d_5f_5f_5f_5$

where the levels 33 and 55 are the boundary levels and 44 indicates the layer for which data are missing.

5. Modification of Code Form FM 42-XI AMDAR

Modify the Code Form FM 42-XI AMDAR by changing the fifth group GGgg of section 2 to YYGGgg. Regulation 42.1.2.1 will be change to:

42.1.2.1 Subject to Regulation 42.1.2.2 an AMDAR report shall include Section 2 containing at least the phase of flight indicator, the aircraft identifier, its geographical location, the day and time of observation, as well as the observed temperature and wind.

6. Changes to FM 63-X Ext. BATHY **code form**

The BATHY code form needs to be changed to permit higher precision in the specification of the position of the observation. The position groups are expanded to six characters and will be reported in decimal degrees rather than degrees and minutes. This is exactly the same way that positions are reported in FM-18 BUOY. The regulations for use would be the same as in FM-18 BUOY (see regulation 18.2.4). Since all operators cannot perform the change at the same time, it is necessary to have a new value for M_jM_j. That value is chosen so that it does not conflict with any entries presently in Code table 2582 of the *Manual on Codes*.

6.1 Amend section 1 of the BATHY code form with the proposed changes shown in bold:

$M_iM_iM_jM_j$ YYMMJ GGgg/ $Q_cL_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_oL_o$ ....

with $M_iM_iM_jM_j$ = **JJVV** (update Code Table 2582 accordingly)

6.2 Insert new regulation:

63.2.2 Groups $Q_cL_aL_aL_aL_aL_a$ $L_oL_oL_oL_oL_oL_o$

Position shall be reported in tenths, hundreths or thousandths of a degree, depending on the capability of the positioning system. When the position is in tenths of a degree, the groups shall be encoded as $Q_cL_aL_aL_a$// $L_oL_oL_oL_o$//. When the position is in hundredths of a degree, the groups shall be encoded as $Q_cL_aL_aL_aL_a$/ $L_oL_oL_oL_oL_o$/.

6.3 Renumber existing regulation 63.2.2 to 63.2.3.

7. Changes to FM 64-IX TESAC **code form**

The position groups are expanded to six characters, and now will be reported in decimal degrees rather than degrees and minutes. This is exactly

the same way that positions are reported in FM-18 BUOY. The regulations for use would be the same as in FM-18 BUOY (see regulation 18.2.4). It is proposed to add the same group as in BATHY to record the type of instrument used in making the temperature and salinity measurements. Regulations for the use of this table would be the same as used in BATHY (see regulation 63.3.1) except in the specification of the group that it follows. It will be necessary to change the identification of the TESAC from KKXX to KKYY so that decoders can distinguish between the newer form and the old one (since I_X can start with the value of '2', which follows as the identifier of the depth group as well).

7.1 Amend section 1 of the BATHY code form with the proposed changes shown in bold:

SECTION 1 $M_iM_iM_jM_j$ YYMMJ GGgg/ $Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$ .....

with $M_iM_iM_jM_j$ = **KKYY** (update Code Table 2582 accordingly)

SECTION 2 $888k_1k_2$ $I_XI_XI_XX_RX_R$ .....

7.2 Insert new regulation:

64.2.2 Groups $Q_cL_aL_aL_aL_a$ $L_oL_oL_oL_oL_o$

Position shall be reported in tenths, hundreths or thousandths of a degree, depending on the capability of the positioning system. When the position is in tenths of a degree, the groups shall be encoded as $Q_cL_aL_aL_a$// $L_oL_oL_oL_o$//. When the position is in hundredths of a degree, the groups shall be encoded as $Q_cL_aL_aL_aL_a$/ $L_oL_oL_oL_oL_o$/.

7.3 Renumber existing regulation 64.2.2 to 64.2.3.

7.4 Insert new regulation:

64.3.1 Group $I_XI_XI_XX_RX_R$

This group is mandatory and shall follow immediately after the $888k_1k_2$ group.

7.5 Renumber existing regulations 64.3.1, 64.3.2 and 64.3.3 to 64.3.2, 64.3.3 and 64.3.4.

8. Addition to FM 65-XI WAVEOB regulations

To eliminate a weakness existing in the WAVEOB code, whereby some optional section ought to be present when other sections were coded, the following addition is required:

- In Note 3 following the CODE FORM definition, change text in brackets to read:

  (Sections 1 to 5 are optional. However if any of section 2, 3, 4 or 5 is present, section 1 must be present).

9. Add Code Table to define data-processing techniques used when retrieving satellite data (I_4 used in FM 86 SATEM and FM 87 SARAD)

Code Table 1761 for Alphanumeric Codes

I_4 – Data-processing techniques used

Code figure

0	Processing technique not specified
1	Clear path, using automated statistical regression
2	Partly cloudy path, using automated statistical regression
3	Cloudy path, using automated statistical regression
4	Clear path, using automated statistical regression with interactive quality control
5	Partly cloudy path, using automated statistical regression with interactive quality control
6	Cloudy path, using automated statistical regression with interactive quality control
7–9	Reserved

NOTES:

(1) Clear path means the sounding has been generated from clear radiances derived from actual clear spot measurements. Tropospheric and stratospheric HIRS data, as well as MSU and SSU data, have been used.

(2) Partly cloudy path means the sounding has been generated from clear radiances which have been calculated from partly cloudy spots. Tropospheric and stratospheric HIRS data, as well as MSU and SSU data, have been used.

(3) Cloudy path means the sounding has been generated only from stratospheric HIRS data, MSU data, and SSU data. Tropospheric HIRS data have not been used because of cloudy conditions.

RECOMMENDATION 7 (CBS-Ext.(98))

REVIEW OF RESOLUTIONS OF THE EXECUTIVE COUNCIL BASED ON PREVIOUS RECOMMENDATIONS OF THE COMMISSION FOR BASIC SYSTEMS OR RELATED TO THE WORLD WEATHER WATCH

THE COMMISSION FOR BASIC SYSTEMS,

NOTING with satisfaction the action taken by the Executive Council on the previous recommendations of the Commission for Basic Systems or related to the WWW in general,

CONSIDERING that some of the previous Executive Council resolutions are still valid,

RECOMMENDS that the following Executive Council resolutions be kept in force:

Resolutions 1 and 2 (EC-XXXVI), 5 (EC-XLII) and 5 (EC-XLIX);

and that Resolution 4 (EC-XLIX) is no longer needed and should not be kept in force.

ANNEXES

ANNEX I

Annex to paragraph 4.1.20 of the general summary

STATEMENT OF THE CBS TECHNICAL CONFERENCE ON INTEGRATED UPPER-AIR OBSERVING (KARLSRUHE, GERMANY, 28–29 SEPTEMBER 1998)

Preamble

There is an increasing need for upper-air observations to support higher resolution NWP, particularly at the mesoscale, and to monitor, understand and predict climate. This need cannot be fulfilled within the present GOS that relies on balloon-launched radiosondes and other observing components. A number of studies on the impact of upper-air observing stations and networks had been carried out nationally and through several international projects. These studies were discussed at the WMO/CGC Workshop on the Impact of Observing Systems on Numerical Forecasts (Geneva, April 1997) and at the WMO Expert Meeting on the Future Composite Upper-air Network (Geneva, May 1997). As a result of these discussions, it was concluded that further exploration of the availability of alternative systems and the development of a strategy for a composite upper-air observing system was necessary. The Executive Council, at its forty-ninth session, therefore requested the Secretary-General to convene a technical conference on integrated upper-air observing under the auspices of CBS. At the kind invitation of the Government of Germany, the conference was held in Karlsruhe, from 28 to 29 September 1998, in conjunction with the extraordinary session of CBS.

The Conference was attended by 85 participants from 40 countries including 13 invited scientific experts. It covered a wide range of topics, in particular the changing needs for upper-air data, the current status of implementation and deficiencies in the global upper-air network, observing systems opportunities, and composite network planning and design. Two topics were presented as keynote addresses: the observational factor in improving services in today's environment and the evolution to an integrated observing system component. The participants at the Conference recommended that appropriate steps be taken in developing an integrated upper-air observing strategy within WWW, which can meet the growing requirements of the WMO Programmes and other international organizations. A summary of the Conference findings is given below.

Observational requirements for upper-air data

The success of a future integrated upper-air observing is fundamental to the science of meteorology and it must cope with the existing and growing requirements of WMO Programmes, of WMO-supported Programmes, and of the world scientific community, including the challenges of sustainable development in the twenty-first century. Furthermore, it is recognized that such an integrated approach should be cost-effective. The new system must include the need for improved weather predictions for the mitigation of natural disasters such as tropical and mid-latitude storms including severe local and tornadic storms, floods, persistent extreme temperatures and droughts. Improved prediction capabilities will benefit also other programmes dealing with issues related to the escalating world population and related food security, human health protection, freshwater availability and sustainable development, the global energy needs, and the degradation of environmental quality including the urban environment. The new system should also allow monitoring and detection of climate trends and change, and should support regional climate studies. Observational data requirements are constantly evolving along with advances in data-processing methods and techniques, the needs for wider applications in meteorology and climatology research, as well as demands for better services. The requirements are also influenced greatly by increasing capabilities of individual observing systems or mixes of systems and the ability to integrate observations into a useful data assimilation scheme. Efforts to maintain all encompassing lists of requirements inevitably call for compromises to be made between important diverse needs, and it should be kept in mind that requirements, or their relative priorities, may differ from region to region and between a wide range of economic and social activities which benefit from observational data. Observational data requirements will no doubt continue to increase in scope, including enhanced timeliness, spatial resolution and accuracy. The observing system as a whole must be designed to meet all of the requirements in the most cost-effective manner using an appropriate mix of individual technologies, strategies and techniques. The requirements for climate research, analysis and prediction will need an upper-air database that will allow testing of the basic scientific hypotheses and understanding of the physical mechanisms that determine the behaviour of the coupled climate system on different

time-scales. Climate analysis requires a baseline network of consistent high-quality long-term observations. This is the role of GUAN, which now includes a baseline network of about 150 selected upper-air stations of the WWW. As the needs for upper-air data for climate research and prediction continue to evolve, the effort to improve the integrated upper-air observing system should be coordinated between WWW and GCOS.

To meet observational data requirements, a composite upper-air observing system should:

(*a*) Satisfy long-term needs of relevant WMO Programmes, WMO-supported Programmes, and a wide variety of purposes and uses into the first few decades of the twenty-first century;

(*b*) Provide consistent and uniform global coverage, especially over the oceans;

(*c*) Apply appropriate technologies, so that all countries can maintain and operate satisfactorily their national components of the system and benefit in a sustainable and self-reliant manner;

(*d*) Make data available and accessible within the framework of Resolution 40 (Cg-XII) — WMO policy and practice for the exchange of meteorological and related data and products including guidelines on relationships in commercial meteorological activities.

Additionally, a truly "integrated system" will depend on the investment in data assimilation, which will include an increase in scientific studies and computer resources. This is especially important because present efforts in assimilating data into complex coupled models indicate that significant increases in computational capability are still needed. It is also important to improve utilization of existing datasets (e.g. raw radiosonde data, Doppler radar data, etc.) in NWP. GDPS centres involved in the preparation of re-analysis datasets in the past should be encouraged to implement periodically the re-analysis to obtain a consistent long-term data records for the study of climate variations and change.

Other additional factors forcing changes

In addition to growing requirements, there are several factors affecting the current global upper-air network which lead to the necessity of developing an integrated upper-air observing system. They include:

Reduced national budgets for systematic measurements: Financial constraints and changing national priorities result in reduced numbers of staff and operational sites; increasing numbers of contract-based programmes; reductions in training of staff; and inadequate materials and consumables for fully implementing observational programmes. Increased strategic investments to develop cost-efficient technologies can result in new, less costly systems that demonstrate greater reliability and enhanced performance.

Changes in the status of reliant technologies (e.g. Omega, and possible Loran shutdowns and GPS introduction): The rapid evolution in telecommunications and navigational aids, on which the upper-air network is operating, has stimulated nations to upgrade equipment and modify operational practices.

Increased problems with radio frequency allocation: Increasing spectrum occupation by meteorological satellite and mobile satellite systems will necessitate improvement in many radiosonde receiver systems and improvement in the frequency stability of some radiosonde types. The coordination between NMSs and their telecommunication authorities to ensure adequate recognition and consideration of the issue at the World Radiocommunication Conferences remains vitally important and should be continued.

Year 2000 compliance: To ensure that mission-critical weather observing, prediction and dissemination systems function reliably into the next millennium, computer specialists around the world are devoting significant efforts to the year 2000 problem. This is causing, in some cases, temporary resource pressure in dealing with near-term issues.

Advances in upper-air measurements science and technology: New technology can be designed to address needs for higher quality data and/or increased (and/or strategically placed) numbers of atmospheric profiles or soundings. Efforts to address performance deficiencies and inadequate spatial and temporal resolutions can significantly impact on network configuration and are expensive to develop and implement. From a global perspective, development of a standard reference radiosonde would allow the comparison of the performance characteristics of different systems and could lead to the development of an internationally-agreed upon set of system performance standards. Advances in accurate and consistent observations of water vapour are also needed.

Initial components of a composite upper-air observing system

A number of recent observing systems experiments (OSEs) and observing systems simulation experiments (OSSEs) containing data from various observing systems such as satellite radiances, aircraft observations and satellite derived winds were used in comparison to standard NWP controls. These experiments have provided further insight into what a composite upper-air observing system could be based upon. The initial components of such a system are expected to include:

(*a*) More uniform coverage of radiosonde stations that will be based on various windfinding systems including the use of GPS and on improved temperature and moisture sensors and implement new operating scenarios on variable frequencies of observation times. Altitude and accuracy of soundings should be increased so this network could also serve as a baseline network for the validation of satellite measurements;

(*b*) A significantly improved automated aircraft reporting scheme that includes observations from both cruise level as well as on ascent and descent providing

profiles of the atmosphere on an expanded world-wide coverage;

(*c*) An increase in high resolution observations, particularly in the lower troposphere, from radars, wind profilers, and other ground-based remote sensing systems;

(*d*) Present and improved capabilities from the existing and future generation of meteorological satellites and technologies for data retrievals, particularly over land areas;

(*e*) Improved observations of water vapour in the troposphere and low stratosphere;

(*f*) A global consistent high-quality baseline network of ground-based and satellite-based observations for climate purposes;

(*g*) New strategies for providing adaptive observations through the use of dropwinsondes or unpiloted aeronautical vehicles;

(*h*) An enhanced system of surface-based and satellite measurements of chemical constituents, as a part of GAW.

Well-planned studies such as those under way by CGC, the North American Atmospheric Observing System (NAOS) Programme and the European Composite Observing System (EUCOS) Programme are important steps toward a uniform, reliable, cost-effective and scientifically-sound system that will provide meteorological data for weather prediction and climate monitoring and research. Taken together with the results of OSEs and OSSEs, findings of the CGC, NAOS and EUCOS can provide a real basis for the planning and initiation of a coordinated global approach to achieve what would be an integrated upper-air observing. Input from across all WMO Programmes will be required to ensure that all requests are addressed to the extent practical. The time is right for WMO Members to plan for new additions and modifications to today's composite upper-air observing system. This effort should consider proven technology and techniques, implications of recent advances and opportunities presented by emerging technology. No single technology, currently existing or foreseen, can meet all requirements. The new composite system must utilize a range of mutually-complementary technologies, some of which could become operational only after a considerable development effort. The operational deployment of a modern composite upper-air system might also require a fundamental shift in the way that countries contribute to the WWW.

Summary of recommended actions

In order to reach the goals of the integrated upper-air observing system, the following activities will need to be undertaken:

(*a*) To evaluate and advise on observational data requirements of the WWW, other WMO and international programmes supported by WMO and to recommend measures to meet those requirements: Database of observational requirements for WMO Programmes and WMO-supported Programmes as compiled by the CBS Working Groups on Observations, on Data Processing and on Satellites should be used for this purpose;

(*b*) To arrange a coordinated global approach among WMO Members: This will include building upon, where appropriate, regional mechanisms to establish a new global mechanism involving representative groups of WMO Members from all regions and representatives of all WMO Programmes;

(*c*) To identify a realistic system design by developing observing system scenarios to be tested through OSEs and OSSEs and comparing the conclusions with the observational requirements of all WMO Programmes: This will require cooperation between experts on observing systems, data assimilations, NWP models and operational forecasting. Advanced GDPS centres should be requested by CBS to carry out appropriate impact studies, guided by testable hypotheses and related to proposed scenarios. Of equal importance in identifying the results of the impact test is the identification of the costs and benefits of proposed changes to the network. This methodology employed by NAOS, including the test of both rawinsonde and other remote-sensing systems, should be extended for global coverage. This should include the introduction of "targeted" or "adaptive" observations techniques. An international framework for these studies can be provided through the CAS/Joint Scientific Committee (JSC) Working Group on Numerical Experimentation;

(*d*) To develop partnerships with airline, shipping industries and others to assure further development of automated meteorological reports from commercial aircraft, voluntary observing ships and buoys: Regarding aircraft platforms, this will require the establishment of an appropriate and affordable mechanism for receiving and processing the new aircraft data on ascent and descent, which would not be a burden to the aircraft operators. Countries where large upper-air data-sparse areas exist should investigate the possibility of their involvement in the AMDAR programme through consultation with the AMDAR Panel. Regarding ship platforms, an expansion of ASAP by development of ASAP systems on ships operating in specific data-sparse areas is recommended. The data buoy projects within the framework of the WMO/IOC DBCP should be expanded to include additional data-sparse areas;

(*e*) To investigate systematically suitable options for the integration of new upper-air observing technologies supplementing the conventional systems, e.g. windprofilers, unpiloted aeronautical vehicles (UAV's), etc.: Wind profilers have reached a stage of operational reliability that offers their integration in a composite upper-air observing system provided cost-efficiency could be demonstrated. Research aircraft and dropwinsondes have been tested and found useful in experiments such as the Fronts and Atlantic Storm Track Experiment (FASTEX) and the

North Pacific Experiment (NORPAX). Their use or more cost-efficient solutions such as UAV's should be further studied in their operational environment possibly under international control;

(*f*) To maintain a close collaboration with the satellite operating agencies to ensure continued development of observing technology and the continuation of the constellation of polar-orbiting and geostationary satellites, encouraging optimum use of our collective satellite-based assets: This will include collaboration with CGMS and CEOS in developing new and more precise instruments. New instruments are being planned for flight before the end of the first decade of the new millennium. Instruments will soon be available to provide three-dimensional wind fields, vastly improved temperature and humidity profiles, atmospheric constituents, oceanographic fields required for operational ocean and basic circulation models and detailed cryospheric information. WMO should ensure that adequate guidance is provided to space agencies in determining future programmes and missions;

(*g*) To ensure the needed participation of developing countries and countries with economies in transition in fulfilling the requirements of the composite system within their national territories: This will require continuation and enhancement of donor countries' involvement through appropriate mechanisms, the improvement of supporting functions of data management and telecommunications infrastructure, and the provision of enhanced use of satellite data in all WMO Regions. The developing countries must learn from the lessons and experience of the developed countries in the construction of sophisticated observational instruments and equipment. In particular, they must avoid using those international technologies and instruments which are already obsolete. WMO should provide the necessary support and guidance to the developing countries in this regard, in particular, for developing, manufacturing or purchasing this standardized affordable, effective and advanced observational instruments and equipment. A wide range of education and training activities is needed to support the transfer of technology, knowledge and experience to the developing countries;

(*h*) To prepare design criteria for the further development of the integrated upper-air observing system: CBS-Ext.(98), in collaboration with experts from other technical commissions and relevant international programmes, should implement an appropriate mechanism.

ANNEX II

Annex to paragraph 4.2.8 of the general summary

COVERAGE OF THE WMO REGIONS BY SATELLITE DISTRIBUTION SYSTEMS

Region	*Complete or near-complete coverage by:*	*Partial coverage by:*
I	ISCS (Atlantic) MDD* UKSF/WWW	FAX-E RETIM
II	UKSF/WWW**	ISCS (primarily ISCS (Pacific)) MDD MTSAT (planned for March 2000) TV-Inform-meteo Systems operated by China*, India and Thailand
III	EMWIN-E ISCS (Atlantic) and ISCS (Pacific)	MDD System operated by Argentina
IV	EMWIN-E ISCS (Atlantic)* and ISCS (Pacific)	MDD
V	ISCS (Pacific)*** MTSAT (planned for March 2000)	EMWIN-W
VI	MDD FAX-E* ISCS (Atlantic) RETIM* UKSF/WWW	

* Component of the RMTN. ** Pilot project. *** Integration into the RMTN under consideration.

ANNEX III

Annex to paragraph 4.2.18 of the general summary

THE COMPREHENSIVE CATALOGUE OF METEOROLOGICAL BULLETINS

1. Introduction

CBS-XI agreed upon the general principles for the improved Catalogue of Meteorological Bulletins and invited the WG-TEL to develop formats and procedures. An ad hoc team of experts (Messrs L. Bezrouk (WMC/RTH Moscow) and H. Ichijo (RTH Tokyo)) was established to refine the formats and procedures and test them. The proposals were reviewed by the Implementation Coordination Meeting on the MTN (1997) and were endorsed by the fourteenth session of the CBS/WG-TEL.

2. General concepts of the comprehensive Catalogue of Meteorological Bulletins

The format and the procedures are based on the following concepts:

(*a*) Each of the responsible RTHs should maintain a database containing the valid catalogue in each zone of responsibility and the advanced notification of the changes of the valid catalogue;

(*b*) The valid catalogue and the advanced notification should be available to Members by general access procedures. Furthermore, their formats should be independent from any application software. Even if the responsible RTHs are different from each other in the kind of database software used for internal management, all the RTHs should provide the valid catalogue and the advanced notification in the common formats;

(*c*) In addition to each database in each zone of responsibility, the overall database containing the complete valid catalogue and the complete advanced notification should be located at the WMO Secretariat (and a mirror site if possible);

(*d*) The Members should notify the responsible RTH in their zone of necessary information on any amendments beforehand;

(*e*) After checking the information, the responsible RTH should provide the advanced notification of the changes of the valid catalogue to the Secretariat as soon as possible. The Secretariat is supposed to dispatch them via advance telegraphic notification relating to the operation of WWW (METNO) messages to all Members;

NOTE: The definition of METNO messages is described in the introduction of *Weather Reporting* (WMO-No. 9), Volume A. It, however, does not allow carrying out a notification on changes in the comprehensive Catalogue of Meteorological Bulletins. The WMO Secretariat may be invited to add new parts for deletion, addition and modification in the Catalogue to the METNO definition.

(*f*) The responsible RTH should update the valid catalogue periodically, at least twice a year (by 1 March and 1 September), in accordance with the advanced notification, which has already become effective. When the valid catalogue is updated, the responsible RTH should provide the updated valid catalogue to the Secretariat.

NOTE: The deadline for updating was decided in consideration of editing work for the new versions of Volume C1 and the possibility of use for the WWW non-real-time monitoring.

An outline of the structure of the comprehensive Catalogue of Meteorological Bulletins in accordance with these concepts is shown in Figure 1.

3. Formats and procedures

3.1 ***Key points to be considered in the development of formats and procedures***

(*a*) The formats of the comprehensive Catalogue (the valid catalogue and the advanced notification) should be independent from any database and/or spreadsheet application software. It is desirable that the comprehensive Catalogue can be easily ingested or imported into most databases and/or spreadsheet application softwares;

(*b*) The comprehensive Catalogue should be provided as files with their appropriate sizes by FTP server and/or, if necessary, by diskette. The FTP will be basically used for providing the comprehensive Catalogue because of its popular use by the Members;

(*c*) The comprehensive Catalogue should be usable for not only UNIX workstations but also for DOS and WINDOWS basis PCs;

(*d*) The advanced notification should be understandable by itself and available for the preparation of METNO messages;

(*e*) For a Member's reference, files of the advanced notification should be stored in the database of the responsible RTH for a few years (not less than one year).

3.2 ***Valid catalogue***

3.2.1 File format and file names

(*a*) The valid catalogue is divided into two files. One is for observational data and the other is for products;

NOTE: It should be considered how to catalogue graphical information such as charts in T4 facsimile and imagery data in JPEG format, if necessary.

(*b*) The files are provided in ASCII format;

(*c*) The file name is "CCCCmddF.txt", where:

(i) "CCCC" is the international four-letter location indicator (capital letters) of the responsible RTH for the updating of the Catalogue;

(ii) "m" is the month of updating the file (1...9 = January...September and A...C = October... December);

(iii) "dd" is the day of updating the file;

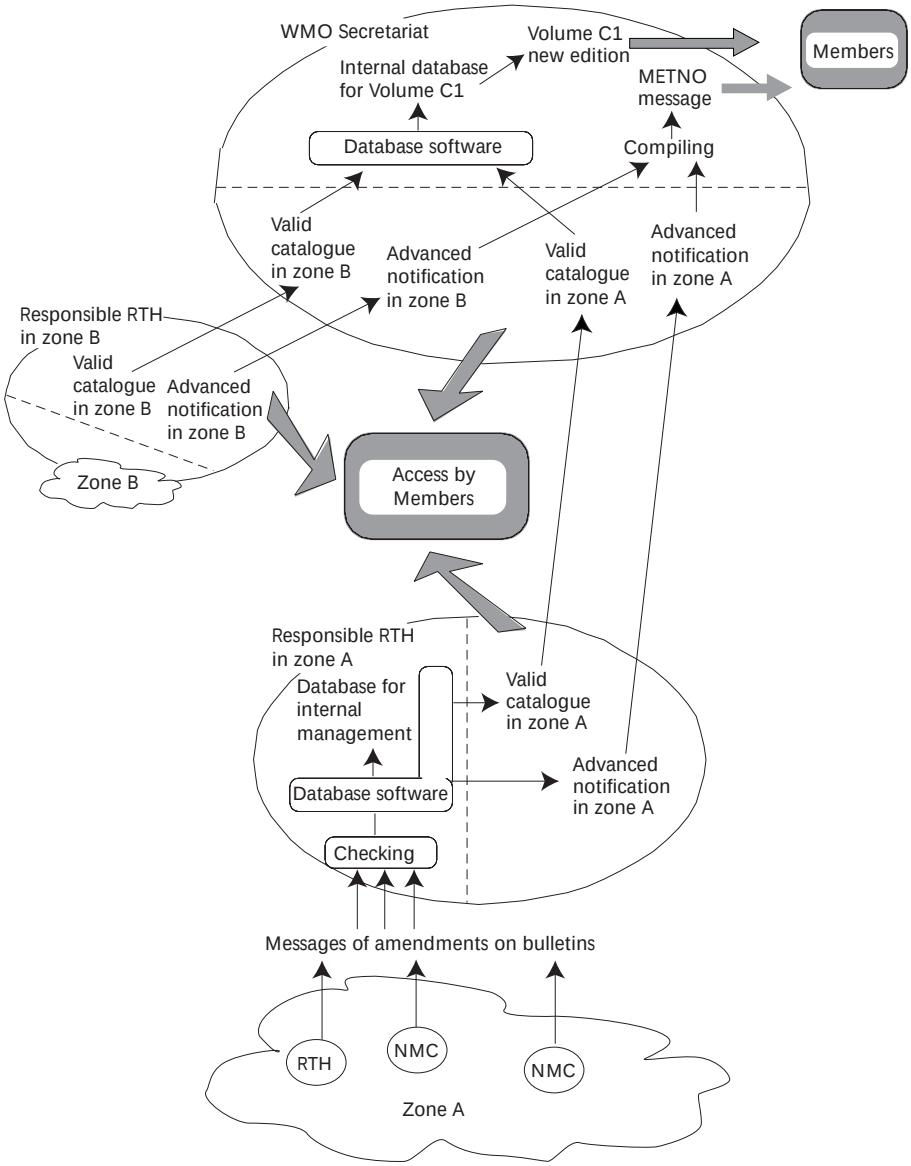


Figure 1 — Outline of the structure of the comprehensive Catalogue of Meteorological Bulletins.

(iv) "F" is the file identification to distinguish the type of the contents (O = observational data file and P = product file);

(v) The extension "txt" is a constant character-set (small letters) which indicates a file in ASCII format;

NOTE: In case of a server which has no distinction between capital and small letters in the file system, either of them is used for the file name.

(*d*) The files are stored in both the FTP server in the responsible RTH and the WMO FTP server according to the following directory naming rule:

"/...(sub-directories)..../CCCCyyyy/ (file name), where:

(i) "CCCC" is the international four-letter location indicator of the responsible RTH;

(ii) "yyyy" is the year of compiling the file; (Examples: "/.../RUMS1997/RUMSA11O.txt', "/.../RJTD1998/RJTD410P.txt");

(*e*) In case that the files are stored in a floppy disk, the following directory naming rule is applied: "/CCCCyyyy/ (file name).

3.2.2 General rules on the record and fields

(*a*) The fields in the "CCCCmddO.txt" file are the same as the ones in the "CCCCmddP.txt" file;

(*b*) Each record has 12 fields. Each field is quoted by double quotation marks (" ") and delimited by a comma (,) (i.e. "a field" , "a field' , "a field" , . . .);

(*c*) Although the record length is variable, each record is in one line. The end of each record must be marked by a set of a carriage return (CR) and a line feed (LF) so that not only UNIX but also PC basis applications can handle the record easily;

(*d*) The first record in the file shows the field names;

(*e*) The fields such as "RTH", "Country", "Centre" and "Remarks" are described in English only.

3.2.3 Field definition

No.	*Field name*	*Type*	*Width*	*Description*
1	Region	Numeric	1	1=Region I; 2=Region II; ... ; 6=Region VI 7=Antarctic Region number in which the centre shown in the field "Centre" is located. In case of the bulletin including data from Antarctic stations, this field should be 7.
2	RTH	Character	Variable	Name of the RTH which has zone of responsibility corresponding to the bulletin.
3	Country	Character	Variable	Name of the country where the centre is located. It is desirable to set the country name in accordance with specifications in Code tables No. 5.1 to 5.7 in *Weather Reporting* (WMO-No. 9), *Volume C*.
4	Centre	Character	Variable	Name of the centre (usually the NMC) which originates the bulletin or controls the originator of the bulletin.
5	Date	Character	10	Date from which this record becomes effective, in the form of day/month/year (e.g. 05/12/1998 for 5th December 1998).
6	Category	Character	1	A= "Additional data/products" E= "Essential data/products" O= "Other data/products".
7	TTAAii	Character	6	T1T2A1A2ii of the abbreviated heading.
8	CCCC	Character	4	CCCC of the abbreviated heading.
9	Code form	Character	Variable	Code form used for coding of data or products contained in the bulletin. It is desirable to set the code form in accordance with specifications in Code table No. 1 in *Weather Reporting* (WMO-No. 9), Volume C.
10	Time group	Character	Variable	Times in UTC for the bulletin issued at a fixed time everyday. This field may be the same as GG in the YYGGgg group of the abbreviated heading. Day of month for the bulletin issued on a fixed day every month. Other comment on issuance of a bulletin could be inserted in the "Remarks" field. It is desirable to set the times or periods in accordance with specifications in Code table No. 2 in *Weather Reporting* (WMO-No. 9), Volume C.
11	Content	Character	Variable	Contents of the bulletin (e.g. station index numbers, ICAO location indicators). For GRID and GRIB bulletins, area of coverage and grid spacing should be inserted in this field. The text of bulletins in accordance with specifications in Code table No. 3 in *Weather Reporting* (WMO-No. 9), Volume C may be set.
12	Remarks	Character	Variable	Memo field used for any information not described in the preceding fields. In case that the contents of a GRID/GRIB bulletin differs from those derived from the abbreviated heading, such information, as parameters on actual contents, should be inserted in this field.

3.3 Advanced notification of changes

3.3.1 File format and file names

(*a*) Each advanced notification including some changes is a file in ASCII format with a file name different from each other;

(*b*) General definition in the file name is "CCnnmddF.txt", where:

(i) "CC" is the first two letters of the international four-letter location indicator "CCCC" of the responsible RTH;

(ii) "nn" is a sequence number of the advanced notification file. There are two different series of the sequence number (01 to 99) for two types of file identification (i.e. "F"= O and "F"= P) which are initialized at the beginning of each year;

(iii) "m" is the month of compiling the file (1...9 = January ... September and A...C = October...December);

(iv) "dd" is the day of compiling the file;

(v) "F" is the file identification to distinguish the type of the contents (O = advanced notification file for changes in observational data and P = advanced notification file for changes in products);

(vi) The extension "txt" is a constant character-set (small letters) which indicates a file in ASCII format;

(*c*) The files are stored in both the FTP server in the responsible RTH and the WMO FTP server according to the following directory naming rule: "/...(sub-directories)..../CCCCyyyy/AN/ (file name), where:

(i) "CCCC" is the international four-letter location indicator of the responsible RTH;

(ii) "yyyy" is the year of compiling the file;

(iii) "AN" is a constant sequence meaning abbreviation of "Advanced Notification".

(Examples: "/.../RUMS1998/AN/RU21C05O.txt", "/.../RJTD2000/AN/RJ02229P.txt");

(*d*) In case that the files are stored in a floppy disk, the following directory naming rule is applied: "/CCCCyyyy/AN/ (file name).

3.3.2 General rules on the records and fields

(*a*) The record structure is basically the same as that of the valid catalogue, and a file can contain several records to change the valid catalogue;

(*b*) Each record has 15 fields which are 12 fields of the valid catalogue and three new fields (i.e. sequence number, type of change, and effective date of change). The use of field quotation and delimiter is the same as that of the valid catalogue;

(*c*) Basically the types of change are deletion of an existing record and addition of a new record. Even in case of modification of an existing record, it is possible to change the catalogue by a combination of deletion and addition. However, in view of human understanding for compiling METNO messages, it is desirable to add the supplementary information for the modification case to those two types:

(i) "DD" for deletion of an existing record and "AA" for addition of a new record are defined as the basic type of change;

(ii) In addition to the basic types, "DM" for deletion of an existing record to be modified and "AM" for addition of the modified record can be used to indicate the modification explicitly;

(iii) In case of the use of the "DM" and "AM", the placement order of the records in the file is important. The record to be modified with the type of "DM" should be followed by the modified one with the type of "AM". It shows that the "DM" record is replaced by the "AM" one;

(*d*) The first record in the file shows the field names.

3.3.3 Field definition

No.	*Field name*	*Type*	*Width*	*Description*
1	Sequence No.	Numeric	4	Sequence number of this change record according to the increment manner through the year. There are two different series of the sequence number (0001 to 9999) for two types of changes in "observational data" and in "products" which are initialized at the beginning of each year.
2	Change type	Character	2	Type of change of the record whose contents are shown in the last twelve fields (fields No. 4 to 15). DD = deletion of the record AA = addition of the record DM = deletion of the record for modification AM = addition of the record for modification
3	Change date	Character	10	Date from which this change becomes effective, in the form of day/month/year (e.g. 01/01/2000 for 1st January 2000).
4 to 15	Definitions of the following fields (fields No. 4 to 15) are the same as the ones of the fields (fields No. 1 to 12) in the valid catalogue, respectively.			

3.4 ***Arrangement for access to the Catalogue of Meteorological Bulletins***

Each responsible RTH should make the files of the valid catalogue and the advanced notification available on its own FTP server (and on WWW's server, where possible). If a responsible RTH has no server, the WMO FTP server can be used to make the relevant files accessible to Members as a temporary measure.

3.5 ***Procedures for maintaining the Catalogue of Meteorological Bulletins***

3.5.1 Informing on amendments to the bulletins to the responsible RTH

NMCs and RTHs should inform the responsible RTH in their zone of any amendments on the bulletins generated by them in advance (e.g. a month before implementation of the amendments). The message of amendments should include enough information to change the valid catalogue. It should be especially noted that the date of implementation of the amendments is indispensable not only for changes to the valid catalogue but also for compilation of the advanced notification.

Although means of informing on the amendments in each zone could be arranged between the responsible RTH and NMCs/RTHs concerned, it is desirable to use a real-time basis means such as e-mail, facsimile and addressed message on the GTS.

3.5.2 Checking the message of the amendments by the responsible RTH

Each responsible RTH should check that the contents of the amendment message is in conformity with the standard and recommended practices and procedures in the *Manual on the GTS* (WMO-No. 386) and should liaise with the NMC/RTH when any questions related to the application of these practices and procedures are raised.

Furthermore, it is desirable that each responsible RTH periodically surveys consistency between the catalogue and the received bulletins.

3.5.3 Sending the advanced notification to the WMO Secretariat

Each responsible RTH should send an advanced notification to the WMO Secretariat when fair amendments on the bulletins generated in its responsible zone are confirmed. In practice, FTP PUT procedures are used to transfer a file of the advanced notification to the appropriate directory on the WMO FTP server. In addition to FTP, an e-mail should be sent to the WMO Secretariat to notify the transfer. The file of the advanced notification is also stored in the FTP server of the responsible RTH as a part of the comprehensive catalogue to be available to the Members.

3.5.4 Updating the valid catalogue and transferring it to the WMO Secretariat

The responsible RTH should update the valid catalogue in its FTP server periodically in accordance with the information in the advanced notification that has already become effective after the implementation date. The responsible RTH should provide the updated valid catalogue to the WMO Secretariat when it is updated. The procedures are the same as the ones for the advanced notification, that is, FTP PUT procedures with notification by e-mail.

Although the cycle of the updates depends on the condition of the responsible RTH, the valid catalogue shall be updated at least twice a year (by 1st March and 1st September) for the Secretariat's work on new editions of *Weather Reporting* (WMO-No. 9), Volume C1.

3.6 ***An outline of procedures***

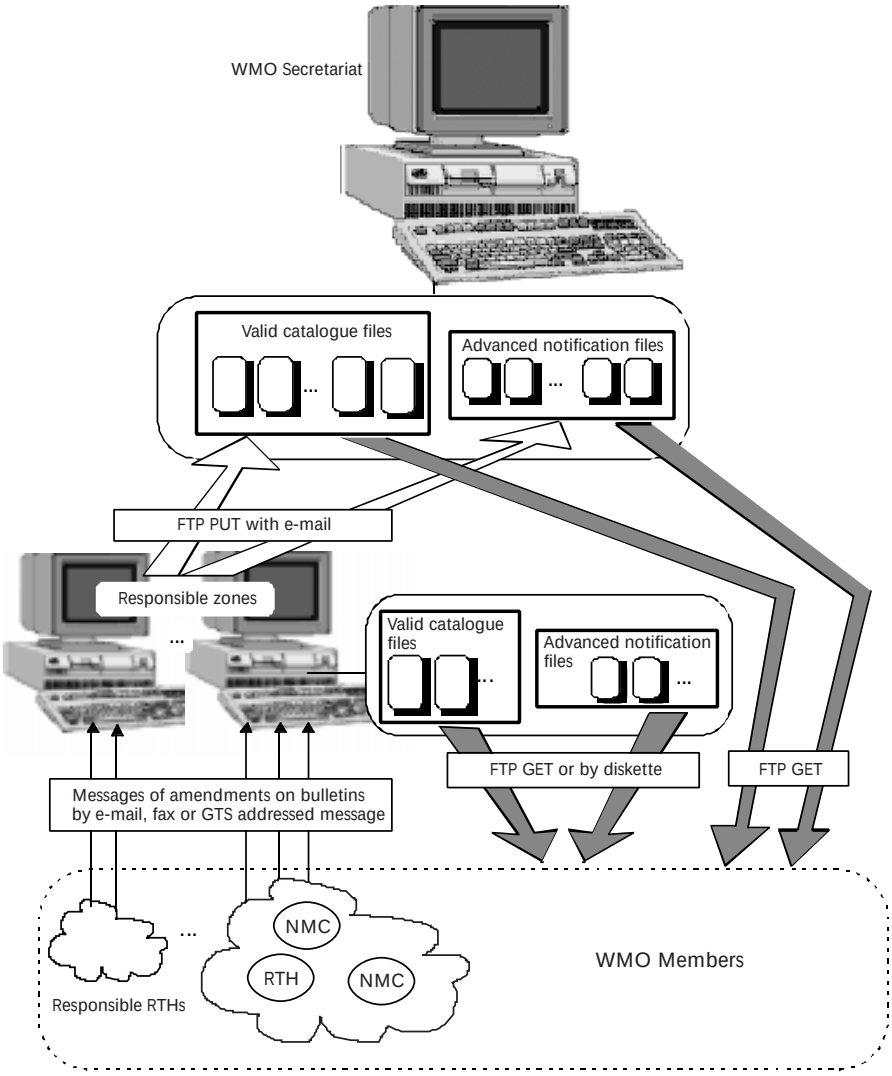


Figure 2 — Procedures for access and maintenance.

3.7 ***Examples of formats and procedures***

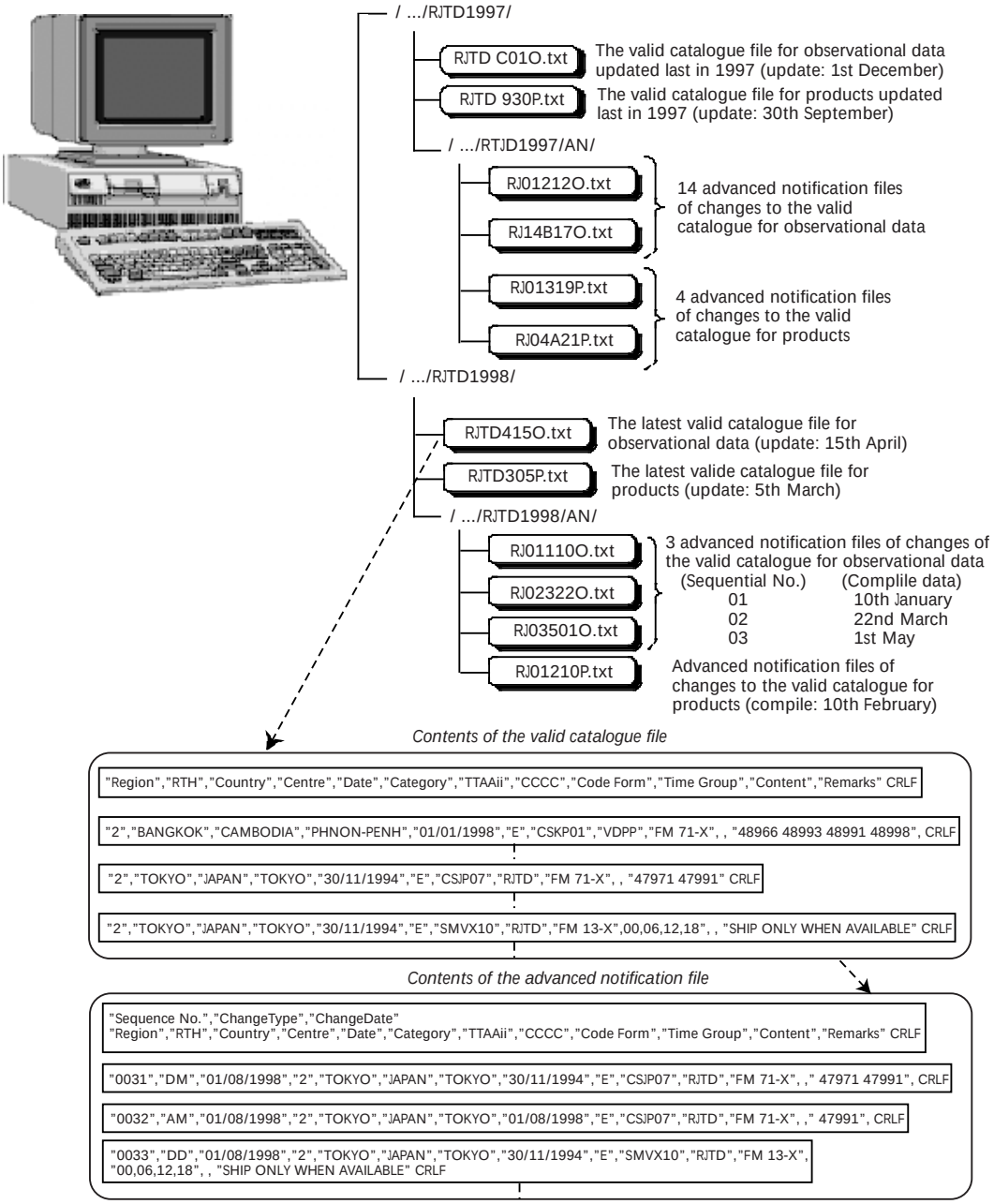


Figure 3 — An example of the comprehensive Catalogue of Meteorological Bulletins in RTH Tokyo.

ANNEX IV

Annex to paragraph 4.3.11 of the general summary

VERIFICATION SYSTEMS FOR LONG-RANGE FORECASTS — EXPERIMENTAL SCORES TO BE EXCHANGED IN THE FIRST PLACE

This proposal defines the core standardized verification system (SVS) for long-range forecasts as proposed jointly by CAS, CCl and CBS experts. The core SVS has been designed to provide a straightforward assessment system for all predications in the medium range and longer time scales; nevertheless it can be used at the short range also. The objectives of the SVS are covered in detail in Annex 1. The two prime objectives are:

(*a*) To provide ongoing standardized verification statistics on real-time forecasts for exchange between GDPS centres and for annual submission to CBS;

(*b*) To provide standardized methods of verification that can be attached to any real-time prediction in order that information concerning the inherent skill of the forecast system is passed to the recipient.

The SVS is formulated in four parts:

(*a*) Diagnostics. Two diagnostics are included and are closely defined. Additional diagnostics are suggested but are not incorporated into the core SVS as yet. Use of the additional diagnostics is optional;

(*b*) Parameters. Key variables for initial inclusion are proposed. However the list is flexible to ensure that all producers can contribute regardless of the structure of individual forecast systems;

(*c*) Verification datasets. Key datasets of observations against which forecasts may be verified are proposed. This list is also flexible to ensure that all producers can contribute regardless of the structure of individual forecast systems;

(*d*) System details. Details of forecast systems employed.

Diagnostics

Two diagnostics are incorporated in the core SVS — relative operating characteristics and root mean square (RMS) skill scores. Both provide standardized values permitting direct intercomparison of results across different predicted variables, geographical regions, forecast ranges, etc. Both may be applied in most verifications and it is proposed that, except where inappropriate, both diagnostics be used on all occasions.

(*a*) Relative operating characteristics. Calculation details are discussed in Annex 2. For deterministic forecasts, values of the hit rate and the false alarm rate should be supplied. For probabilistic forecasts, the following information should be supplied: details of the interval in probability space between values, for each interval the hit rate and the false alarm rate, and the standardized area under the curve (such that perfect forecasts give an area of 1 and a curve lying along the diagonal gives 0.5);

(*b*) Root mean square skill scores. Calculation details are discussed in Annex 3; root mean square skill scores are appropriate only for deterministic forecasts. In general, two skill scores should be provided: against persisted anomalies and against climatology. Where persistence is not relevant as a predictor (such as for some seasonal rainfall regimes) only skill against climatology should be assessed. A further three individual values (two when persistence is not used) should be provided: RMS error values for forecast, persistence and climatology.

Parameters

The key list of parameters in the core SVS is provided below. Any forecasts for these key parameters should be assessed using both core SVS techniques wherever possible. Many seasonal forecasts are produced which do not include parameters in the key list (for example, there are numerous systems which predict seasonal rainfall over part of, or over an entire, country). The core SVS diagnostics should be used to assess these forecasts also, but full details of the predictions will need to be provided.

(*a*) Sea surface temperature predictions. Predictions for:

Niño 1+2
Niño 3
Niño 3+4
Niño 4
[further standard areas may be defined];

(*b*) Atmospheric parameters. Predictions for:

T2m screen temperature with standard regions: Tropics 20°N to 20°S
Northern extratropics >20°N
Southern extratropics <20°S
For both extratropical regions split also into separate land and oceanic regions

Precipitation with standard regions:	Tropics 20°N to 20°S Northern extratropics >20°N Southern extratropics <20°S For both extratropical regions split also into separate land and oceanic regions
500 hPa geopotential height with standard regions:	Northern extratropics >20°N Southern extratropics <20°S
850 hPa temperature with standard regions:	Tropics 20°N to 20°S Northern extratropics >20°N Southern extratropics <20°S For both extratropical regions split also into separate land and oceanic regions

In using relative operating characteristics, a definition of the binary 'event' being predicted is required. While flexibility in defining the event is proposed, the recommendation is that each event be either above or below normal or a tercile of the climatological distribution.

Verification datasets

The key list of datasets to be used in the core SVS for both climatological and verification information is provided below. Many seasonal forecasts are produced that may not use the data in either the key climatology or verification datasets (for example, there are numerous systems which predict seasonal rainfall over part of, or over an entire, country). Appropriate datasets should then be used with full details provided.

(*a*) **Sea surface temperature**
Climatology: Either GISST or Reynolds OI (to be specified in returns)
Verification: TAO data for *El Niño* predictions; any standard aggregation method for spatially averaging SST anomalies, with near-real-time products from UKMO (GISST) and NCEP (Reynolds OI) recommended.

(*b*) **Precipitation**
Climatology: Xie-Arkin
Verification: GCOS Network

(*c*) **T2m screen temperature**
Climatology: Xie-Arkin
Verification: GCOS Network

(*d*) **500 hPa geopotential height**
Climatology: ECMWF Reanalysis
Verification: ECMWF Analysis

(*e*) **850 hPa temperature**
Climatology: ECMWF Reanalysis
Verification: ECMWF Analysis

When gridded datasets are used, a 2.5° by 2.5° grid is recommended.

System details

Information will be requested concerning the following details of the forecast system:

(*a*) Is the system numerical/hybrid/empirical?
(*b*) Do the results relate to independent forecasts/hindcasts/simulations/empirical model training?
(*c*) Is the system deterministic/probabilistic?
(*d*) List of parameters being assessed;
(*e*) List of regions for each parameter;
(*f*) List of forecast ranges (lead times) and periods (e.g. seasonal average) for each parameter;
(*g*) The number of predictions incorporated in the assessment and the dates of these predictions;
(*h*) Details of climatological and verification datasets used (with details of quality controls when these are not published);
(*i*) If appropriate, resolution of fields used for climatologies and verification;
(*j*) The period over which data are averaged to produce persisted anomalies.

Core SVS use

Exchange of information between GDPS centres: For centres using global numerical models it will be possible to use the core SVS for information exchange in a similar manner to that already in place using the CBS short-range verification system based on RMS errors. Most centres will be producing ensembles, and it is recommended that the grand ensemble mean be used for the deterministic prediction. Probabilities can be created through simple counting of members predicting a specific binary event. Thus, an exchange could be arranged of verifications for all parameters in Part 2 of the parameter list using the proposed climatology and verification datasets. Centres using coupled models can include parameters in Part 1. Other centres mainly those without global numerical prediction capabilities, might arrange exchanges as appropriate for the products they produce, including the possibility of exchanging information with numerical modelling centers with geographic regions defined in terms of specific products from individual centres. The possibility of providing standard software of the calculations will be investigated.

Annual submission to WMO: Annual submissions to WMO will be requested in standard form, permitting all

GDPS centres to contribute. The possibility of submission through Web Forms pages will be investigated.

Attachment to real-time predictions: It is strongly recommended that all real-time predictions should be tagged with information concerning skill using the core SVS approach. In providing information, the forecaster should provide verification directly related to the specific forecast fields. Not only should ROC hit and false alarm rates plus RMSSS values be provided, but the background to the verification should also be supplied. Background information includes details of methods used, including whether these can be viewed as a historical time-series of fully-independent forecasts, the number of predictions included, the technique used and any known details concerning variations in skill, such as between *El Niño*/Southern Oscillation (ENSO) and non-ENSO years.

Possible additional diagnostics: The CBS Working Group recommended a number of diagnostics beyond those suggested by the CAS Working Group. The core SVS currently incorporates only the CAS recommendations; the CBS recommendations are listed in Annex 4.

ANNEX 1 — OBJECTIVES OF THE STANDARDIZED VERIFICATION SYSTEM (SVS)

The SVS has two major objectives:

(*a*) To provide a standardized method whereby forecast producers can exchange information on the quality of longer-range predictions on a regular basis and can also report annually results to WMO as part of consolided annual summary;

(*b*) To provide a standardized method whereby forecast producers can add information on the inherent qualities of their forecasts for the information and advice of recipients.

In order to achieve the first major objective, the SVS incorporates two diagnostics and a series of recommended forecast parameters and verification and climatological statistics against which to assess the forecasts which can be applied to real-time forecasts, either on an individual basis or, preferably, accumulated over a sequence of predictions.

The second major objective is achieved using the same diagnostics, forecast parameters and verification and climatological statistics but applied to historical tests of the system. It is made clear whether the historical tests are based on methods that can be considered to represent a true forecast had the test been run in real time or otherwise. Producers will be requested to add this information to issued predictions; recommendations for methods by which this might be done may be formulated later.

Other objectives of the SVS are:

(*a*) To encourage both regular verification of forecasts and verification according to international standards;

(*b*) To encourage information on inherent forecast quality to be added to all predictions as a matter of course and to encourage forecast recipients to expect receipt of the information;

(*c*) To encourage producers to use consistent datasets and to encourage production of these datasets;

(*d*) To provide verifications that permit direct intercomparison for forecast quality regardless of predicted variable, method, forecast range, geographical region, or any other consideration;

(*e*) To encourage producers to work towards a common method for presenting forecasts.

ANNEX 2 — RELATIVE OPERATING CHARACTERISTICS (ROCs)

The derivation of relative operating characteristics (ROCs) is given below. For purposes of reporting forecast quality for exchange between centers and for annual submission to WMO, the following will be required:

(*a*) For deterministic forecasts hit rates and false alarm rates together with essential details of the forecast parameter and verification datasets;

(*b*) For probabilistic forecasts hit rates and false alarm rates for each probability interval used. Frequent practice, as illustrated below, is for probability intervals of 10 per cent to be used. However, other intervals may be used as appropriate (for example, for nine-member ensembles, an interval of 33.3 per cent could be more realistic). Additionally, the area under the curve should be calculated.

ROCs, derived from signal detection theory are intended to provide information of the characteristics of systems upon which management decisions can be taken. In the case of weather forecasts, the decision might relate to the most appropriate manner in which to use a forecast system for a given purpose. ROCs are useful in contrasting characteristics of deterministic and probabilistic systems.

Take the following 2x2 contingency table for any yes/no forecast for a specific binary event:

		FORECASTS		
		YES	NO	
OBSERVED	YES	Hits (H)	Misses (M)	H + M
	NO	False alarms (FA)	Correct rejections (CR)	FA + CR
		H + FA	M + CR	

The binary 'event' can be defined quite flexibly, e.g. as positive/negative anomalies, anomalies greater/less than a specific amount, values between two limits, etc. If terciles are used, then the binary event can be defined in terms of predictions of one tercile against the remaining two.

Using stratification by observation (rather than by forecast), the following can be defined:

Hit rate = H/(H + M)

False alarm rate = FA/(FA + CR).

For deterministic forecasts, the hit rate and false alarm rate only need to be calculated; for probabilistic forecasts, the procedure outlined below should be followed.

A probabilistic forecast can be converted into a 2×2 table as follows. Tabulate probabilities in, say, 10 per cent ranges stratified against observations, i.e.:

Probability range	*Number of observed events for each probability range*	*Number of non-observed events for each probability range*
90–100%	O_{10}	NO_{10}
80–90 %	O_9	NO_9
70–80 %	O_8	NO_8
60–70%	O_7	NO_7
50–60 %	O_6	NO_6
40–50%	O_5	NO_5
30–40%	O_4	NO_4
20–30%	O_3	NO_3
10–20%	O_2	NO_2
0–10%	O_1	NO_1
Totals	ΣO_i	ΣNO_i

For any threshold, such as 50 per cent (indicated by the dotted line in the table), the hit rate (false alarm rate) can be calculated by the sum of Os (NOs) at and above the threshold value divided by ΣO_i (ΣNO_i) — in other words, for a value of 50 per cent the calculation is as if the event is predicted given any forecast probability of 50 per cent or more. So for the above case:

Hit rate $= (O_{10} + O_9 + O_8 + O_7 + O_6) / \Sigma O_i$

False alarm rate $= (NO_{10} + NO_9 + NO_8 + NO_7 + NO_6) / \Sigma NO_i$

This calculation can be repeated at each threshold and the points plotted to produce the ROC curve which, by definition, must pass through the points (0,0) and (100, 100) (for events being predicted only for 100 per cent probabilities and for all probabilities exceeding 0 per cent, respectively). The further the curve lies towards the upper left-hand corner the better; no-skill forecasts are indicated by a diagonal line.

Areas under ROC curves can be calculated using the Trapezium rule. Areas should be standardized against the total area of the figure such that a perfect forecast system (i.e. one that has a curve through the top-left-hand corner of the figure) has an area of one and a curve lying along the diagonal (no information) has an area of 0.5. Alternatively, but not recommended in the standard, the 0.5 to 1.0 range can be rescaled from 0 to 1 (thus allowing negative values to be allocated to cases with the curve lying below the diagonal — such curves can be generated). Not only can the areas be used to contrast different curves but they are also a basis for Monte Carlo significance tests. Monte Carlo testing should be done within the forecast dataset itself.

In order to handle spatial forecasts, predictions for each point within the grid should be treated as individual forecasts but with all results combined into the final outcome. Categorical predictions can be treated for each category separately.

ANNEX 3 — ROOT MEAN SQUARE SKILL SCORES

Root mean square skill scores are calculated from:

$$\left(1 - \frac{\text{RMS (forecast)}}{\text{RMS (standard)}}\right) \times 100$$

RMS (forecast) refers to the RMS error of the forecast. RMS (standard) refers to the RMS error of the standard when verified against the same observations as the forecast — the standard can be either climatology or persistence. When persistence is used, the persistence should be defined in a manner appropriate to the time scale of the prediction, although it is left to the producer to determine whether persistence over, perhaps, one month or an entire season is used in assessing a seasonal prediction. No portion of the persistence period should overlap into the forecast period and the forecast range should be calculated from no sooner than the time at which any observed information (i.e. infomation which could not be known at the time of a real forecast) is no longer included. Both of these requirements are placed to ensure that all forecasts and test predictions only use data that were available at the time of the prediction or would have been available at that time had a prediction been made (in the case of historical test).

ANNEX 4 — ADDITIONAL DIAGNOSTICS PROPOSED BY CBS

1. **Categorical forecasts**
   Linear error in categorical space for categorical forecasts (LEPSCAT)
   Bias
   Post agreement
   Per cent correct
2. **Probability forecasts of binary predictands**
   Brier score
   Brier skill score with respect to climatology
   Reliability
   Sharpness (measure to be decided)
3. **Probability of multiple-category predictands**
   Ranked probability score
   Ranked probability skill score with respect to climatology
4. **Continuous forecasts in space**
   Murphy-Epstein decomposition (phase error, amplitude error, bias error)
5. **Continuous forecasts in time**
   Mean square error
   Correlation
   Bias

ANNEX V

Annex to paragraph 4.3.29 of the general summary

DEFINITION OF REQUIREMENTS CONCERNING CHEMICAL INCIDENTS

1. In a broad discussion on meteorological requirement aspects related to chemical incidents it was noted that there was a need to have:
   (*a*) Representative meteorological data reflecting the characteristic atmospheric conditions at and in the vicinity of the incident site;
   (*b*) Data on the evolution of atmospheric conditions within the incident area;
   (*c*) Chemical information database;
   (*d*) Emergency planning and response information including meteorological support aspects;
   (*e*) Expertise at various organizational levels, (e.g. regional to the local level) to provide model output interpretation and/or run very simple models on site to support rapid response;
   (*f*) Dispersion model facilities;
   (*g*) Good communication facilities for rapid receipt of notification and dissemination of results.
2. The above requirements should be considered with a specific focus on:
   (*a*) Data (meteorological observations and incident related);
   (*b*) Tools including models and visualization facilities;
   (*c*) Expertise.

2.1 Data

As input to dispersion models and for understanding and evaluating the dispersion processes involved, data that characterize the atmospheric conditions, especially the local boundary layer and turbulence regime, of the site normally should include:
   (*a*) Wind speed at 10 m;
   (*b*) Wind direction and the directional fluctuations ($\sigma\theta$);
   (*c*) Atmospheric stability (e.g. Pasquil category);
   (*d*) Height of atmospheric boundary layer;
   (*e*) Humidity at surface;
   (*f*) Precipitation — occurrence and type;
   (*g*) Surface temperature;
   (*h*) Boundary layer profile (temperature, humidity, wind);
   (*i*) Prevailing climatological conditions and dispersion climatology.

2.2 There are a number of approaches to obtain the characteristic atmospheric conditions. These may include making arrangements to have deployable mobile weather stations or to establish standard observing facilities installed and operated at the chemical plant sites and to provide such data routinely from the site. Another approach in countries with dense networks and running mesoscale atmospheric models, is that their outputs could be used as input to dispersion models. Mesoscale model output could also serve to indicate the evolution of atmospheric conditions within the incident area.

2.3 To run efficiently such a model and to provide outputs for rapid guidance, there is a need to have an up-to-date integrated system of other related data and information prepared and selectable to include for example, chemical information database, possible accident scenarios, local surface cover characteristics and related response planning information. These may include:
   (*a*) Chemical inventories (e.g. types and quantities, geographically referenced to facilities, and transportation corridors);
   (*b*) Type of possible release (fixed facility, mobile tanks, explosive, flammable, etc.);
   (*c*) Physical characteristics (mapped) of the incident site and nearby or local areas (e.g. out to 50 km);
   (*d*) Action levels (e.g. immediate danger to life and health (IDLH) or lethal dose (LD50)) that are established in emergency response plans and linked to activating specific emergency response activities.

2.4 The available information on the chemical information database and national emergency planning include the United States EPA CAMEO, a computer-based planning and response system designed to help emergency planners and responders at the regional and local levels for, and safely handle, chemical hazards and to address these issues. CAMEO operates in two computer environments, IBM compatibles and Apple Macintosh. It contains chemical specific response information, a planning module for assisting the risk posed by extremely hazardous chemicals, an atmospheric dispersion model to assist in evaluating release scenarios, and a series of related data bases for storing and retrieving information required for planning and response (the latter to serve as place holders for local information). CAMEO information may be displayed on maps to assess the relative risk presented by various chemical release scenarios and to determine response actions to chemical emergencies.

2.5 Tools

Major tools include atmospheric boundary layer and dispersion models for domains less or equal to 50 km. These should assimilate all available local data for diagnostic and prediction purposes. Various factors may come into play in the choice of a suitable model to be run:
   (*a*) Nature and scale of incident (chemical species, emission conditions, surrounding terrain, e.g. open field, urban setting, etc.);

(*b*) Treatment of different dispersion regimes, e.g. heavy gas, passive tracer, or buoyant plume (explosion, fires);

(*c*) Nature of source (chemical release scenario), depending on whether it is a facility or transport incident, or different source term modelling (e.g. jets, pools, flashing liquid) to provide input for specific dispersion model;

(*d*) Input data requirements (some models will require extensive datasets); timeliness in receiving input data and turn-around time of running models will constrain the possible support to response, perhaps limiting response options to only major incidents.

2.6 Several NMSs operate EER procedures and models in support of chemical incidents. These models may be:

(*a*) Empirical ones informed by basic meteorological conditions such as wind velocity, vertical stability, existence of precipitation, etc.;

(*b*) Gaussian models of passive dispersion are easy to run on PCs, require little input data (wind and vertical stability) but are of limited applications;

(*c*) Integral models of heavy gas dispersion may also be run quickly and efficiently on PCs and are applicable to a range of chemical releases;

(*d*) Complex, time dependent, three-dimensional, non-homogeneous models are difficult and expensive to operate in real-time. However, they may be used for scenario simulation of the pollution around a potentially hazardous site, taking into account the small-scale features of the topography. The focus of this application is examining worst cast scenarios for prospective of inputs. It is necessary to run the models on a selected sample of worst case characteristic meteorological condition for each site with due consideration for worst case impacts. Such a catalogue of dangerous areas corresponding to the worse case meteorological situation could be useful in order to determine areas of vulnerability depending on worst case meteorological conditions;

(*e*) Model intercomparison and validation against observational data (e.g. from field trials) contributes to the understanding of the applicability of the various models.

2.7 Assimilation and application of the output information will require:

(*a*) Visualization facilities for estimating hazardous zones from model output (e.g. scalable map size, zoom, pan, sections, animation, overlays, etc.);

(*b*) Geographical information system facilities for detailed interpretation of local meteorological effects on the movement and dispersion of chemicals and aiding in communicating output results using geographical references;

(*c*) Coupling with established action levels for hazards related decision making.

2.8 Expertise

The meteorological expertise required include expert knowledge and information related to the dispersion models and dispersion processes with a view to advising facility operators on meteorological data measurement systems and on implementation and operation of local dispersion models. This also includes:

(*a*) Selecting and operating suitable models;

(*b*) Assessing quality and suitability of model results in the context of specific incidents.

ANNEX VI

Annex to paragraph 4.3.30 of the general summary

ROLE OF NATIONAL METEOROLOGICAL SERVICES (NMSs)

1. Role of NMSs

(*a*) Using and providing all available meteorological data from the NMS network and other agencies' facilities;

(*b*) Implementing and operating tools including meteorological NWP models, local dispersion models, related visualization and geographic information systems and possibly source term models;

(*c*) Review which models are being run at industries or at emergency response agencies so as to ensure proper use of models;

(*d*) Provide meteorological expertise and advice to national, regional and local emergency response teams;

(*e*) Cooperate with the national emergency response/disaster management agencies and play an active support role by participating in emergency contingency planning and simulation exercises.

2. Possible gaps in the provision of services

2.1 While it is recognized that the identified roles of the NMSs are broad in relation to requirements in

supporting emergency response for chemical incidents and that individual NMSs may prioritize certain roles as more critical to implement than others, it should be noted that due to present day operational realities, NMSs are generally not in a position today to provide specialized support to respond to:

(*a*) Very-short time-scale incidents;
(*b*) The near field (i.e. near the source);
(*c*) Complex source and obstacles to flow (e.g. buildings wake);
(*d*) Spills where chemicals are released into a body of water.

2.2 The operational capabilities and communications for the provision of NMS services at the national, regional and local offices to meet emergency response operations may, in some cases, not be assured during emergency situations.

2.3 Issues needing to be addressed include minimum standards for dispersion models with a view to harmonizing of inputs (in relation to measurement data) and outputs (in relation to parameters used in defining hazards). A methodology is needed for calculating uncertainties in the model estimates or the sensitivities of outputs to varying input parameters.

ANNEX VII

Annex to paragraph 4.3.32 of the general summary

GUIDANCE FOR DEVELOPMENT OF THE INTERFACE BETWEEN A NATIONAL METEOROLOGICAL SERVICE AND OTHER EMERGENCY RESPONSE AGENCIES IN CASE OF CHEMICAL INCIDENTS

National level

1. The NMS should take account of existing procedures and make arrangements with agencies responsible for environmental contingency plans to assure participation of the NMS in national, provincial and local contingency planning.
2. Specific action should be taken by the NMS to obtain a registry of chemical sites and holdings. In addition, NMS could assist in developing climatologies of prevailing meteorological conditions at major chemical sites and other high risk zones. The NMS should arrange to acquire *in situ* (plant site) meteorological data routinely and in real-time including remote sensing data.
3. The NMS should build a knowledge base on what are the response arrangements at various levels of authorities in relation to different incidents including particularly roles and responsibilities and communication arrangements.
4. The NMS should make arrangements to participate in tests and exercises related to responses to chemical incidents.
5. The NMS should seek information on, and review dispersion models used by, other national agencies and industries.

Regional (subregional)

6. Interfaces may be required among NMSs (likely within a limited geographical region); appropriate action by NMS may include:

(*a*) Developing bi-national shared stake arrangements with neighbouring NMSs and procedures for response to agreed areas of common concern, in case of transnational boundary incidents;
(*b*) Developing back-up arrangements and procedures for response between NMSs and/or NMS (or NMCs) and RSMCs (EER) in accordance with mutually-agreed conditions.

For neighbouring States, regional and subregional operational response interfaces could be developed and implemented by the NMSs. Specific documentation on how NMS and RSMC deal with chemical accidents should be included as part of relevant contingency plans. Coordination of emergency response, for planning and response to incidents should include:

(*a*) Identification of contact points (programme and operational);
(*b*) Arrangements (e.g. data and information exchange, communications, security of information, exercise);
(*c*) Criteria for activation and deactivation of regional or subregional interface;
(*d*) Harmonizing of the authoritative information on meteorological aspects of the incident as well as the exchange of information on models and data.

ANNEX VIII

Annex to paragraph 4.4.22 of the general summary

FILE CONTENT DESCRIPTION STANDARDS

1. These standards incorporate several basic features. Each file content description character string consists of several information elements separated by a carriage-return or line feed. Each information element consists of an element identification made up of two capital letters followed by an equal sign and element information. The centres originating files to be transferred are allowed to assemble the information elements described into file content descriptions as they see fit. Nevertheless, the resulting descriptions are unambiguous, human readable, and easily convertible into directory locations and file names by the recipients.

2. Alphabetic or alphanumeric entries are used whenever possible and the allowable character set is restricted to A–Z, a–z, 0–9, equal sign (=) and hyphen (-). Finally, use of the dash is reserved for indicating that the information element is a spatial or temporal interval. The following description of the individual elements adheres to these basic principles:

Originating centre	==> OC=cccnnnsss
Data owner	==> OW=cccnnnsss
Documents	==> DO=dddd
Tables	==> TB=tttt
Reference date	==> RD=yyyymmdd
Reference time	==> RT=hhnnss
Data date	==> DD=yyyymmdd
Data time	==> DT=hhnnss
Data date period	==> DP=$yyyy_1mm_1dd_1$-$yyyy_2mm_2dd_2$
Data time period	==> TP=hh_1nn_1-hh_2nn_2
Generating process	==> GP=ppppp
Area of data	==> AR=aaaaaaaa
Data format	==> DF=ffff
Data status	==> ST=stat
Model type	==> MT=mmmmm
Model run	==> MR=rrr
Cycle of run	==> CY=hh
Level of data	==> LV=sddddd
Layer of data	==> LY=$sddddd_1$-$sddddd_2$
Grid	==> GR=gggggggg
PArameter	==> PA=pppppppp
Data category	==> DC=ccccc
Data subcategory	==> DS=sssss

3. The specific description of these information elements is given below. It should be noted that the above list of information elements is not exhaustive and more can be anticipated to be needed. Furthermore, several tables described below are incomplete and others will need to be developed and maintained by the centre responsible for the file.

4. As an example, the United States NCEP might choose to assemble the above information elements into the following generic file content description character string:

(Originating centre)
(Reference date)
(Reference time)
(Generating process)
(Data time period)
(Area of data)
(Data format)
(Data category)
(Data subcategory)

Symbolically, this would appear as:

OC=cccnnnsss
RD=yyyymmdd
RT=hhnnss
GP=ppppp
TP=hh_1nn_1-hh_2nn_2
AR=aaaaaaaa
DF=ffff
DC=ccccc
DS=sssss

A file of radiosonde observations from fixed land sites for the period from 3 hours prior to 2 hours 59 minutes after a reference date/time of 8 December, 1997/1200 UTC encoded in BUFR would then be accompanied by the following file content description character string when exchanged over the enhanced GTS:

OC=usa007003
RD=19971208
RT=120000
GP=obvns
TP=0300-0259
AR=allglobe
DF=bufr
DC=vsndn
DS=raobf

Note that other centres would be free to organize their file content description character strings for the same observational data with a different combination of information elements or with the same information elements but in a different order.

DESCRIPTION OF INFORMATION ELEMENTS

Originating centre l	==> OC=cccnnnsss
where	
OC	==> Indicator for information element “Originating centre”
ccc	==> country
Nnn	==> centre
sss	==> subcentre
Data owner	==> OW=cccnnnsss
where	
OW	==> Indicator for information element data owner
Ccc	==> country
Nnn	==> centre
Sss	==> subcentre

Documents ==> DO=dddd
where
DO ==> Indicator for information element "Documents"
dddd = tcom ==> telecommunications documents
dddd = code ==> data representation (code) form documents
dddd = prod ==> production documents
dddd = drft draft documents

Tables ==> TB=tttt
where
TB ==> Indicator for information element "Tables'
tttt = stns ==> observing station information
tttt = bufr ==> BUFR tables
tttt = crex ==> CREX tables
tttt = grib ==> GRIB tables

Reference date ==> RD=yyyymmdd
where
RD ==> Indicator for information element "Reference date"
yyyy ==> 4-digit year
Mm ==> month
dd ==> day

Reference time ==> RT=hhnnss
where
RT ==> Indicator for information element "Reference time"
hh ==> hour
nn ==> minute
ss ==> second

Data date ==> DD=yyyymmdd
where
DD ==> Indicator for information element "Data date"
Yyyy ==> 4-digit year
mm ==> month
dd ==> day

Data time ==> DT=hhnnss
where
DT ==> Indicator for information element "Data time"
hh ==> hour
nn ==> minute
ss ==> second

Data date period ==> DP=$yyyy_1mm_1dd_1$ $yyyy_2$ mm_2dd_2
where
DP ==> Indicator for information element "Data date period"
$yyyy_1$ ==> number of years (0–9999) before reference date/time data date period begins
mm_1 ==> number of months (00–12) before reference date/time data date period begins
dd_1 ==> number of days (00–31) before reference date/time data date period begins
$yyyy_2$ ==> number of years (0–9999) after reference date/time data date period ends
mm_2 ==> number of months (00–12) after reference date/time data date period ends
dd_2 ==> number of days (00–31) after reference date/time data date period ends

Data time period ==> TP=hh_1nn_1-hh_2nn_2
where
TP ==> Indicator for information element "Data time period"
hh_1 ==> number of hours (00–99) before reference date/time data time period begins
nn_1 ==> number of minutes (00–99) before reference date/time data time period begins
hh_2 ==> number of hours (00–99) after reference date/time data time period ends
nn_2 ==> number of minutes (00–99) after reference date/time data time period ends

Generating process ==> GP=ppppp
where
GP ==> Indicator for information element "Generating process"
ppppp = obsvn ==> observations
ppppp = manal ==> manual analysis
ppppp = oanal ==> objective analysis
ppppp = mfcst ==> manual forecast
ppppp = ofcst ==> objective forecast

Area of data ==> AR=aaaaaaaa
where
AR ==> Indicator for information element "Area of data"
Aaaaaaaa ==> is a string of eight characters. International coordination of a group of frequently used areas would be useful

Data format ==> DF=ffff
where
DF ==> Indicator for information element "Data format"
ffff = alnu ==> traditional WMO alphanumeric code forms
ffff = bull ==> bulletins of observations as exchanged on the GTS

(Abbreviated header lines included)
ffff = bufr ==> WMO BUFR
ffff = crex ==> WMO CREX
ffff = text ==> text written in CCITT International Alphabet No. 5
ffff = t41d ==> CCITT T4-1D facsimile
ffff = f2 ==> CCITT T4-2D facsimile
ffff = giff ==> GIF
ffff = grib ==> WMO GRIB
ffff = mixf ==> Sequence of GTS-formatted bulletins (can contain information of mixed formats)
ffff = jpeg ==> JPEG

Status ==> ST=stat
where
ST ==> Indicator for information element "Status"
Stat ==> TEST for test data
Stat ==> OPER for operational data

Model type ==> MT=mmmmm
where
MT ==> Indicator for information element "Model type"
Mmmmm ==> string of five characters indicating the type of model used (table maintained by originating centre)

Model run ==> MR=rrr
where
MR ==> Indicator for information element "Model run"
Rrr ==> string of three characters indicating the model run (table maintained by originating centre)

Cycle of run ==> CY=hh
where
CY ==> Indicator for information element "Cycle of run"
Hh ==> cycle time in hours

Level of data ==> LV sddddd
where
LV ==> Indicator for information element "Level of data"
s = p ==> pressure
s = h ==> height
s = t ==> potential temperature
s = s ==> sigma
ddddd ==> value of surface. Multiple levels are indicated by setting ddddd = 99999.

Layer of data ==> LY=$s_1$ddddd_1-$s_2$ddddd_2
where
LY ==> Indicator for information element "Layer of data"
s_1s_2 = p ==> pressure
s_1s_2 = h ==> height
s_1s_2= t ==> potential temperature
s_1s_2 = s ==> sigma
ddddd_1 ==> value of lower surface of layer of type s_2.
ddddd_2 ==> value of upper surface of layer of type s_2. (multiple layers are indicated by setting ddddd_1 = ddddd_2 = 99999)

Grid ==> GR=gggggggg
where
GR ==> Indicator for information element "Grid"
Gggggggg ==> is a string of eight characters indicating the grid used (table maintained by originating centre). Multiple grids are indicated by setting gggggggg = all grids. International coordination of a group of frequently used grids would be useful

Parameter ==> PA=pppppppp
where
PA ==> Indicator for information element "Parameter"
Pppppppp ==> is a string of eight characters indicating the parameter (table maintained by originating centre). Multiple parameters are indicated by setting pppppppp = all parameters. International coordination of a group of frequently used parameters would be useful

Data category ==> DC=ccccc
where
DC ==> Indicator for information element "Data category"
ccccc = sflnd ==> surface data — land
ccccc = sfmar ==> surface data — sea
ccccc = vsndn ==> vertical sounding — other than satellite
ccccc = vsnds ==> vertical sounding — satellite
ccccc = sluan ==> single level upper-air data — other than satellite
ccccc = sluas ==> single-level upper-air data — satellite
ccccc = sfsat ==> surface data — satellite

Data subcategory ==> DS=sssss
where
DS ==> Indicator for information element "Data subcategory"

when ccccc = sflnd,
sssss = synop ==> synoptic — manual and automatic

sssss = avnma ==> aviation — manual
sssss = amosx ==> aviation — AMOS
sssss = ramos ==> aviation — RAMOS
sssss = autob ==> aviation — AUTOB
sssss = asosx ==> aviation — ASOS
sssss = metar ==> aviation — routine weather report
sssss = awosx ==> aviation — AWOS
sssss = coavn ==> synoptic — converted aviation
sssss = autox ==> aviation — AUTO(0-9)
sssss = coops ==> cooperative — SHEF
sssss = sclim ==> aviation — supplementary climate data report
sssss = allsc ==> all sub-categories

when ccccc = sfmar,
sssss = ships ==> ship — manual and automatic
sssss = dbuoy ==> drifting buoy
sssss = mbuoy ==> moored buoy
sssss = lcman ==> land-based CMAN station
sssss = oilrg ==> oil rig or platform
sssss = slpbg ==> sea level pressure bogus
sssss = wavob ==> spectral wave information from a sea station or from a remote platform
sssss = allsc ==> all sub-categories

when ccccc = vsndn,
sssss = raobf ==> rawinsonde — fixed land
sssss = raobm ==> rawinsonde — mobile land
sssss = raobs ==> rawinsonde — ship
sssss = dropw ==> dropwinsonde
sssss = pibal ==> pibal
sssss = prflr ==> profiler
sssss = nxrdw ==> NEXRAD winds
sssss = allsc ==> all sub-categories

when ccccc = vsnds,
sssss = geost ==> geostationary
sssss = mstbg ==> moisture bogus
sssss = tovsx ==> polar orbiting— TOVS
sssss = synsy ==> sun synchronous
sssss = allsc ==> all sub-categories

when ccccc = sluan,
sssss = airep ==> air report
sssss = pirep ==> ailot report
sssss = asdar ==> ASDAR
sssss = acars ==> ACARS
sssss = recco ==> report from a meteorological reconnaissance flight
sssss = allsc ==> Aall sub-categories

when ccccc = sluas,
sssss = infus ==> winds derived from cloud motion observed in infrared channels by the United States
sssss = visus ==> winds derived from cloud motion observed in visible channels by the United States
sssss = h2ous ==> winds derived from motion observed in water vapour channels by the United States
sssss = comus ==> winds derived from motion observed in a combination of spectral channels by the United States
sssss = infin ==> winds derived from cloud motion observed in infrared channels by India
sssss = visin ==> winds derived from cloud motion observed in visible channels by India
sssss = h2oin ==> winds derived from motion observed in water vapour channels by India
sssss = comin ==> winds derived from motion observed in a combination of spectral channels by India
sssss = infja ==> winds derived from cloud motion observed in infrared channels by Japan
sssss = visja ==> winds derived from cloud motion observed in visible channels by Japan
sssss = h2oja ==> winds derived from motion observed in water vapour channels by Japan
sssss = comja ==> winds derived from motion observed in a combination of spectral channels by Japan
sssss = infeu ==> winds derived from cloud motion observed in infrared channels by EUMETSAT
sssss = viseu ==> winds derived from cloud motion observed in visible channels by EUMETSAT
sssss = h2oeu ==> winds derived from motion observed in water vapour channels by EUMETSAT
sssss = comeu ==> winds derived from motion observed in a combination of spectral channels by EUMETSAT
sssss = allsc ==> all sub-categories

when ccccc = sfsat,
sssss = ssmit ==> SSM/I — brightness temperatures
sssss = ssmip ==> SSM/I — derived products
sssss = ersar ==> ERS/SAR
sssss = erswn ==> ERS/scatterometer winds
sssss = ersal ==> ERS/Radar altimeter data
sssss = sstnv ==> DOD/Navy sea surface temperatures
sssss = sstns ==> DOC/NESDIS sea surface temperatures
sssss = allsc ==> all sub-categories

ANNEX IX

Annex to paragraph 4.4.46 of the general summary

RECOMMENDATIONS ADDRESSING THE YEAR 2000 PROBLEM

1. Recommendations addressed to NMHSs are as follows:
   (*a*) Give the highest priority to the year 2000 (Y2K) problem in terms of both staff resources and funds;
   (*b*) As the first step in their Y2K compliance effort, NMHS should establish an inventory of all of their computer-based systems down to a level which allows the full configuration to be recorded. This should include hardware, operating system, network components, applications and control files, including version numbers. The inventory should be used to track compliance and changes in configuration that may need additional testing;
   (*c*) Establish priorities, evaluate, repair and test all of their critical computer-based systems whether developed locally, purchased commercially, donated or developed by other Members, etc.;
   (*d*) Require Y2K compliance in specifications and contracts for purchase of any new computer-based systems;
   (*e*) Investigate use of temporary resources (e.g., military telecommunications capability) with which to meet any critical needs in the early days of 2000. Also, RTHs should envisage the possibility of failure of leased lines. The possibility for dial-up communications lines between RTHs should be planned for;
   (*f*) Consider their reliance on outside resources (power, communications, and suppliers), contact these suppliers and develop detailed contingency plans. NMHSs should also develop contingency plans to use manual methods where computer-based systems may fail;
   (*g*) Seek advice, assistance, etc. from RTHs for the tests and transition to the Y2K;
   (*h*) Since the days before and especially after 1 January 2000 may result in unforeseen contingencies, prepare for full manning in the days immediately before and after this date;
   (*i*) Maintain liaison with the appropriate maritime and telecommunications authorities in their respective countries to ensure that the Y2K problem has been taken into account and that ship observations, both surface and upper air, will flow uninterrupted after 31 December 1999;
   (*j*) Provide information on their experiences or results to the Secretary-General — specific information on the compliance status of widely used systems that they have tested would be of particular value;
   (*k*) Prioritize their observing network and ensure equipment at the highest priority sites is compliant;
   (*l*) In case the operational software had been supplied to other Members, the donors should investigate the compliance of this software and either provide compliant versions or provide the information necessary to make the software compliant;
   (*m*) If financial assistance is required, first apply to the national government, then to WMO VCP, the World Bank, the United Nations Development Programme (UNDP), and others. This should be done as soon as possible due to the lack of uncommitted funds and given the long time required to process these requests, secure funds and purchase equipment;
2. Recommendations addressed to the Secretary-General are as follows:
   (*a*) Periodically send all important information to Members in hardcopy (including details for at least the most widely used software/systems);
   (*b*) Develop, with the assistance of Members, an outline to guide Member countries through the development of requirements, the generation of specifications and the procurement of new Y2K compliant systems;
   (*c*) Develop text specifying Y2K compliance for purchase contracts. This information should be placed on the Web site and should be provided to Members with other important information in his periodic mailings;
   (*d*) Continue efforts to solicit funds on behalf of the Member States. This should also provide details of the rules and procedures to be followed when applying for funds and provide guidance on how to prepare a case for funding to ensure that it stands a fair chance of being considered and approved;
   (*e*) Encourage discussions between Members in the Regions to encourage sharing of information and possibly responsibilities. This could include encouraging the formation of regional Y2K self-help groups;
   (*f*) Coordinate the contacting of suppliers of systems sponsored by WMO;
   (*g*) Consider subscribing to the Gartner Group on behalf of Members so that the Gartner Group findings can be distributed;
   (*h*) Advise on the compliance status of CLICOM, especially with respect to, and dependency

on, operating systems and on what alternative follow-up products could be used;

(*i*) Send a letter to NMHSs explaining the risks they face if they do not assign Y2K work the highest priority and that they should ensure that staff assigned to the work are given the chance to succeed without being diverted to, or overloaded with, other tasks;

(*j*) Seek funds to provide one or two Y2K programme and testing specialists who would be available for Member States to submit their test plans and programme plans for review;

(*k*) Consider the production of a Y2K newsletter or e-mail forum;

(*l*) Arrange for expert visits to assist Members with the most critical needs regarding Y2K compliance;

(*m*) Add additional information to the Y2K Web pages, in particular:

(i) A separate page within the Web site for posting lessons learned, ideas, etc. with emphasis on the GTS, RTHs, and GDPS centres;

(ii) A list of Y2K reference publications recommended by Members;

(iii) A reminder to NMHSs of the migration of one level or version of an operating system (OS) to another in order to make the OS Y2K compliant and to include all levels of authorized licenses. This should also include a note that NMHSs should check carefully with the vendor(s) to ensure that all licenses (e.g. compilers, software tools, display utilities, graphics packages) are available in the upgraded configuration;

(iv) A list of generic risks, countermeasures and outline contingency plans for working against possible failures from telecommunications and other utilities once these have been developed;

(v) Guidance on setting up inventories, configuration management and change control procedures developed by Members with experience in these matters;

(vi) Information about software scanning tools, freeware and tools from Members (e.g. The United Kingdom Meteorological Office). This should also include any information on software tools available for macro testing (for example macros in Microsoft applications);

(vii) Information on work around solutions (or contingencies) to common application problems;

(*n*) Consider producing automatic e-mail notification, which can inform Members of important updates to the Web site. Alternatively a "hot news" link on the front page would help.

3. Recommendations for consideration in the CBS Work Plan:

(*a*) Urge its members to ensure that contingency plans are developed and tested (exercised);

(*b*) Urge its members to ensure that the operation of the GTS under their responsibility is properly tested to ensure operation in 2000 and beyond;

(*c*) Develop a set of "standards" to ensure that tests and exercises under post-31 December 1999 conditions are orderly and standardized. These "standards" should be made available to all WMO Members by posting on the WMO Web page;

(*d*) Develop a schedule for testing all levels of the GTS to include: internal testing for each RTH by 31 December 1998; within national networks and between RTHs by 28 February 1999; and between all other centres by 30 April 1999. The results of these tests should be reported to WMO and posted on the Y2K Web page;

(*e*) Consider developing and coordinating a concept for backing up the GTS over the millennium dates. This could involve making limited datasets available on systems such as FAX-E, SADIS, RETIM, MDD, DCP, INTERNET, etc.

ANNEX X

Annex to paragraph 4.4.52 of the general summary

CHARACTER CODES WHICH CARRY YEAR INFORMATION

J – Last digit of the year

FM 18	BUOY	Report of a buoy observation
FM 62	TRACKOB	Report of marine surface observation along a ship's track
FM 63	BATHY	Report of a bathythermal observation
FM 64	TESAC	Temperature, salinity and current report from a sea station
FM 65	WAVEOB	Report of spectral wave information
FM 88	SATOB	Report of satellite observations of wind, surface temperature, cloud, humidity and radiation

JJ – Last two digits of the year

FM 47	GRID	Processed data as grid-point values
FM 49	GRAF	Processed data as grid-point values (abbreviated code)

JJJ – Last three digits of the year

FM 22	RADREP	Radiological data report
FM 39	ROCOB	Report from land rocketsonde station
FM 40	ROCOB SHIP	Report from a rocketsonde launched from a ship
FM 57	RADOF	Radiological trajectory dose forecast
FM 71	CLIMAT	Report of monthly values from a land station
FM 72	CLIMAT SHIP	Report of monthly values from an ocean weather station
	NACLI	
	CLINP	
FM 73	SPCLI	Report of monthly means for an oceanic area
	CLISA	
	INCLI	
FM 75	CLIMAT TEMP	Report of monthly aerological means from land station
FM 76	CLIMAT TEMP SHIP	Report of monthly means from an ocean station

ANNEX XI

Annex to paragraph 4.5.3 of the general summary

PRELIMINARY STATEMENT OF GUIDANCE REGARDING HOW WELL SATELLITE CAPABILITIES MEET WMO USER REQUIREMENTS IN SEVERAL APPLICATION AREAS

A review of how well satellite capabilities meet WMO user requirements has been exercised by the Working Group on Satellites for some WMO applications (NWP, synoptic meteorology, nowcasting, hydrology and agricultural meteorology). This review has utilized a maturing database of satellite capabilities and user requirements. An objective critical review has produced evaluation charts. A subjective interpretation by satellite experts has generated statements of guidance in these applications areas. Some preliminary conclusions regarding satellite capabilities are:

(*a*) There is a continuing need in all application areas for operational continuity of a suite of instruments deployed from at least two polar orbiting platforms and at least five geostationary platforms;

(*b*) The NWP will benefit from the recent microwave enhancements of the advanced microwave sounding unit (AMSU) to the polar satellites (for a clear and cloudy sky sounding capability) and is awaiting high spectral resolution measurements from instruments such as AIRS, IASI and CrIS (for enhanced vertical resolution in clear sky soundings), planned for the 2000s. The measurement of wind profiles remains the most challenging (remote sensing lidar systems offer promise, but need the opportunity to mature). Variational data assimilation techniques offer the potential for improved exploitation of observations with high temporal frequency, such as radiances from instruments on geostationary satellites; for this reason, user requirements are evolving as assimilation techniques mature. It is becoming clear that the expansion of geostationary capabilities to include high vertical resolution clear sky soundings from high spectral resolution infrared

systems and all sky soundings from microwave systems will be very useful;

(*c*) Current satellite systems are unable to satisfy all the user requirements for synoptic meteorology simultaneously with those for nowcasting; at present, rapid small-scale observations impede the regular larger-scale observations. The timely delivery of satellite data and information to users remains a major challenge. Accurate precipitation estimates remain elusive. Both application areas have the need for higher temporal and spatial resolution of measurements such as those to be offered by MSG in the next decade;

(*d*) Hydrology is anticipating some improvement in estimates of snow cover, snow water equivalent, and soil moisture from the experimental ADEOS-II and EOS microwave instrument (AMSR). Operational implementation of microwave capabilities and expansion of VIS/IR and TIR capabilities remain challenges for basin-scale modeling of water and energy balances;

(*e*) Agricultural meteorology needs a leaf area index and land cover measurements with higher spatial resolution; the polar orbiting instruments need to be enhanced to resolve sub 1 km features. Multifrequency synthetic aperture radar systems should be considered as they could offer significant improvements to canopy structure and water content determinations of use in this application area.

ANNEX XII

Annex to paragraph 4.5.4 of the general summary

STRATEGY TO IMPROVE SATELLITE SYSTEM UTILIZATION

Strategic goal	*Major objectives*	*Project*	*Proposed action topics*
To improve systematically the utilization of the GPS space-based subsystem capabilities with emphasis on improving the utilization of satellite data and services in developing countries	To focus on the needs of developing countries	BEN	- Foster improved promotion of systems use at user forum. - Favour multiagency strategy promoting satellite system benefits. - Focus on improved warning and monitoring of environmental hazards such as severe weather, volcanic ash, air and ocean pollution, etc.
		DPD	- Study the concept of specialized centres and networks to assist NMHSs in the use of satellite data, e.g. new applications, NWP products. - Promote better transfer from research to operational applications. - Focus in high identified priority user requirements for satellite applications. - Assure closer operational development links with PIs. - Implement operational distributed database system. - Study specifications for improved WMC/RSMC satellite products.
	To improve the use of satellite data through increased capabilities in its applications by direct involvement of existing WMO Member expertise	E&T	- Favour the implementation of specific satellite E&T programmes in RMTC's and organization of other relevant WMO training activities. - Expand United States-based virtual lab network in RAs III and IV. - Focus on better use of polar–orbiting data and products. - Evaluate the status of aid projects (Swiss, Italian, etc.). - Seek CGMS help for assuring the continuity of Indian Ocean/RA II satellite coverage. - Propose major WMO project on low-cost satellite workstation.
	To improve the access to satellite data through increased effectiveness in the distribution of satellite system data and products at major hubs, in particular those maintained by satellite operators, WMO WMC's RSMC and other entities as appropriate	INF	- Promote the expansion of EUMETSAT MDD system use in RAs I and II. - Focus on effective use of LRIT in RAs II and V (with MTSAT-1). - Focus on a smooth transition from WEFAX/APT to LRIT/LRPT. - Focus initial funding on workstation and networking. - Expand use of DCP/DRS for agriculture and hydrology. - Pursue improved performance of the MTN and GTS to accommodate increasing flows of satellite data. - Promote a better use of Internet and systems such as VSAT.
		RM	- Continuously perform critical review process of satellite data availability and use linking monitoring to action plans. - Review WMO requirements for new Earth observation satellite data.

Proposed action items are considered under the following project areas:

BEN = Improve benefits, mainly through promotion.
DPD = Data processing and development of new methodologies.
E&T = Education and training.
INF = Infrastructure, including receiving stations, DCP, MDD equipment, etc. and TLC.
RM = Continuous review and monitoring activities.

ANNEX XIII

Annex to paragraph 6.2 of the general summary

DRAFT TEXT FOR INCLUSION IN THE FIFTH WMO LONG-TERM PLAN (5LTP)

Programme 1.3 Global Data-processing System (GDPS)

Implementation for the period 2000–2003

6.1.22 Implementation components of the programme will include:

(*a*) Enhancement of the quality and use of the NWP output from short-range up to multi-seasonal time-scale and dissemination of an increasing amount of GDPS output for exchange on the GTS by expanding the use of high performance computer systems and the spreading application of computer workstations;

(*b*) Development and operational application of PC-based post-processing tools for the generation of value-added ensemble-based forecast products for improving weather and climate services;

(*c*) Encourage research in the development and operation of workstation versions of limited domain regional/local NWP models and NWP output-driven application models for environmental quality, hydrological/flood, and sea state prediction, with horizontal resolution of a few kilometers and post-processing tools for improving prediction services;

(*d*) Development of advanced data-assimilation techniques to facilitate the useful incorporation of new types of observational data into the analysis process and the more effective exploitation of existing data types such as high-resolution satellite data and Earth-based remote sensing data;

(*e*) Development and operation of numerical general circulation type coupled models that will contribute to the generation of improved long-range forecast products;

(*f*) Introduction of improved medium-range forecast products useful up to 10 days;

(*g*) Development of standards for model verification techniques including internationally-agreed forms and formats for presenting results;

(*h*) Acquisition and assimilation of new data types such as oceanographic observations and atmospheric chemistry by major GDPS centres running global coupled models for climate predictions;

(*i*) Study of product requirements in the light of scientific and technological advances, coordination of output programmes of major centres, and development of systematic procedures to monitor and evaluate the provision of warnings and the prediction of critical changes in the quality of the environment;

(*j*) Assistance and support to developing countries for the further development and sustainability of their GDPS functions, including emerging centres with international responsibility through making available expert services for definition of needs, and implementation of appropriate hardware and software, technical guidance including expert missions in support of the implementation of the GDPS at the regional and national levels and the organization of relevant workshops and training events;

(*k*) Emphasis on the role of the human forecasters with the increase support from the progressive development of automatic systems. It is essential to ensure the availability of well-trained forecasters able to evaluate successfully and automatically enhance produced forecasts successfully in short-range forecasting and in case of severe weather and in the development of efficient interactive tools. RMTCs should develop materials to train forecasters in the use of these products and tools.

Programme 1.4 WWW Data Management (DM)

Paragraph 6.1.27:

Replace (*b*) with the following:

(*b*) Expanded use of BUFR, CREX and GRIB table-driven codes as the primary formats for the worldwide exchange of meteorological observations. Ensuring that encoding/decoding software for BUFR, CREX and the new edition of GRIB (with its defined application interface) is developed, maintained, and distributed by designated centres to all interested users. Recommendations on the applicability of widely used standards for the exchange of imagery and graphical information to the requirements of WMO Programmes. Maintenance of character-based codes, as required.

ANNEX XIV

Annex to paragraph 8.2 of the general summary

WORK PROGRAMME OF THE OPEN AREA PROGRAMME GROUPS (OPAGs)

FUTURE WORK PROGRAMME — OPAG ON INTEGRATED OBSERVING SYSTEMS

Observational data requirements

(*a*) Update and document observational data requirements of the WWW, other WMO and international programmes supported by WMO and to assess the capability of both surface-based and space-based systems to meet them;

(*b*) Prepare an update of the Statement of Guidance comparing observational requirements with expected space- and surface-based system performances to include additional application areas (atmospheric chemistry, marine meteorology and aeronautical meteorology);

(*c*) Review requirements for present weather from automatic weather stations for all WMO Programmes and develop or refine, where necessary, quantitative definitions of weather phenomena for which observations are required (see general summary paragraph 4.4.20);

Redesign and long-term strategy for the GOS

(*d*) Assess the capabilities of new observing systems or improvements of those existing, in particular with a view to reducing deficiencies in the existing GOS;

(*e*) Prepare and maintain reviews of impact assessments conducted by GDPS and other NWP centres under programmes activities, such as the North Atlantic Ocean Stations (NAOS), COSNA and EUCOS, that are relevant to the design and implementation of composite observing systems;

(*f*) Prepare and maintain reviews of surface-based and space-based observing systems (including radar and remote sensing systems) that are candidate components of the future composite GOS;

(*g*) Study hypothetical changes to the GOS, prepare a prioritized list of proposals which are both practicable and amenable to testing and suggest mechanisms for testing them;

(*h*) Prepare reports on impact and benefits of satellite data in NWP (linked to OSSEs);

(*i*) On the basis of the above actions, develop criteria for dealing with design issues of the future composite GOS, paying particular attention to developing countries and the southern hemisphere. Issues of costing, joint funding and management of the GOS should be addressed;

GCOS

(*j*) Prepare and maintain reviews of observing systems that are being designed under the auspices of GCOS (GUAN, GSN) and provide feedback to Members in maintaining the quality of the networks;

Systems utilization and products

(*k*) Follow-up the strategy of improved satellite system utilization (see general summary paragraph 4.5.4);

(*l*) Develop an action plan and recommendations based on questionnaires on the use of satellite data and products; in cooperation with the OPAG on PWS, prepare a plan for increased awareness of the utilization of satellite data and products in NMHS;

(*m*) Prepare a report on the impact of the virtual laboratory on education and training in satellite matters in RAs III and IV;

(*n*) Provide guidance on migration of low-cost satellite receiving stations to LRIT;

(*o*) Finalize a report for CBS members on passive microwave sensors applications;

Year 2000 problem

(*p*) Advise on the year 2000 problem related to observing systems;

General tasks

(*q*) Update regulatory and guidance material on GOS and make recommendations for amendments; coordinate with CIMO and other bodies in matters of duplication and inconsistencies between GOS, CIMO and other *Guides* and *Manuals*, and of the inclusion of regulatory material in the *Manual on the GOS* (WMO-No. 544), and incorporate the Statement of Guidance in the *Guide* (WMO-No. 488) and *Manual on the GOS*;

(*r*) Advise on relevant training material, seminars and workshops.

FUTURE WORK PROGRAMME — OPAG ON INFORMATION SYSTEMS AND SERVICES

Data communication systems, techniques and protocols

(*a*) Further develop technical guidance material for the implementation, use and application of TCP/IP-based services in the GTS;

(*b*) Develop technical guidance material for the implementation of co-existing Internet and GTS facilities at WWW centres, including security aspects, with a view to ensuring efficient and safe operations of information systems;

Improved MTN and telecommunication networks

(*c*) Develop a project for an improved MTN, including supported applications, data transport functions, responsibilities of MTN centres, interfaces and gateways between the MTN and RMTNs, and administrative aspects, with a view to its approval by CBS-XII in 2000 and its implementation by 2002 (see general summary paragraphs 4.2.32 to 4.2.34);

(*d*) Provide guidance on technical, operational and administrative/financial aspects of telecommunication techniques and services for WWW operations, specially for the implementation of the GTS (in particular for RMTNs), including dedicated and public services (e.g. satellite-based telecommunications, managed data-communication network services, ISDN, and the Internet);

(*e*) Review the structure and the operational organization of the GTS to take benefit from data-communication techniques and telecommunications services, with a view to meeting cost-effectively WWW requirements for real-time operational data exchange, including satellite data, and other WMO information exchange requirements as feasible (see general summary paragraph 4.5.4);

Operational information exchange management

(*f*) Develop further operational information exchange procedures with a view to improved WWW operation, especially the GTS, including:

(i) Data collection and distribution (updating abbreviated headings tables);

(ii) Routeing and traffic management for the exchange of observational data and processed products (development of detailed routeing plans);

(iii) Procedures for exchanging information in the form of bulletins and files (filenaming, FTP flow between centres);

(iv) Definition of metadata standards;

(*g*) Coordinate and develop further guidance on the management of, and access to, operational information related to WWW information exchange, especially to the GTS operation (abbreviated heading tables, catalogue of bulletins and files, routing directories, etc.);

WWW monitoring

(*h*) Further develop and consolidate monitoring and follow-up procedures for the production, collection, distribution and exchange of information in the WWW, in coordination with the other OPAGs and other technical commissions, as appropriate;

Year 2000 problem

(*i*) Advise on the year 2000 problem related to WWW operational systems, including the exchange of information and compliance testing, with respect to GTS and data management facilities;

Information management

(*j*) Collect information on the volume and timeliness requirements for the data and products to be exchanged on the GTS and other telecommunications systems used to meet requirements of WMO Programmes;

(*k*) Review and revise, as necessary, the DDBs concept in light of the evolution of user requirements, the growing use of the Internet and the implementation of TCP/IP on the GTS;

(*l*) Update the *Guide on WWW Data Management* (WMO-No. 788) while reorganizing it into the proposed outline for the *Guide on WWW Data Management*; develop an outline and vision for the WMO Data Management Plan;

Guide on Internet practices

(*m*) Develop a guide on Internet practices, according to general summary paragraph 4.4.42;

Data representation and codes

(*n*) Distribute a questionnaire to ask each Member of WMO which codes they use, how they use them, and the operational and planned capabilities for automatic processing of these data. Analyse the results with a view to proposing a strategy for reducing the number of codes;

(*o*) Propose a standard data format for the exchange of imagery and other satellite products;

(*p*) Further develop GRIB-2;

(*q*) Maintain and develop further code tables so they meet the requirements of all Members most efficiently, including AWS reporting;

(*r*) Develop standard data descriptor sequences (templates) for the exchange of data encoded in all traditional character formats in BUFR and CREX; invite Members to participate in the experimental exchange of such data on a bilateral basis;

(*s*) Investigate how encoding/decoding software for BUFR/CREX and the new edition of GRIB could be developed and maintained so as to facilitate the wider use of these data representation codes;

General tasks

(*t*) Develop a strategic overview of integrated information systems and services;

(*u*) Advise on WMO training material, seminars and workshops on telecommunication, database and data management techniques and operations;

(*v*) Update relevant regulatory and guidance material.

FUTURE WORK PROGRAMME — OPAG ON DATA PROCESSING AND FORECASTING SYSTEMS

Impact of changes of the GOS on the GDPS

(*a*) Plan and coordinate the analyses of the NWP verification exchanged by GDPS with a view to developing methods and procedures for assessing planned and unplanned changes to the GOS on the operation of the GDPS;

Forecasting systems

(*b*) Continue the review and finetuning of methods used in the standardized data quality monitoring and verification of NWP products and the exchange of results;

(*c*) Continue to coordinate the development and implementation of a verification system for long-range

forecasts to monitor their reliability, with a view to improving their accuracy;

(*d*) Develop the capabilities of the GDPS to fulfil Members existing and newly emerging requirements by coordinating the development of training material and organizing workshop/training seminars on the application and use of GDPS outputs including atmospheric model transport products;

(*e*) Provide advice and develop guidance, in collaboration with CCl and CAS, on issues related to the distribution and use of seasonal to interannual climate predictions in the global, regional and national contexts;

(*f*) Review the ensemble prediction system operated by GDPS centres with a view to providing recommendations on products, guidance material on the interpretation and potential use by NMHSs in various activities including severe weather warnings, among others;

(*g*) Review and report on the uses made of various workstations in NMHSs including such items as the costs, software and support. Identify areas of potential collaboration and standardization;

Emergency response and related activities

(*h*) Coordinate the development of services in support of the activities of CTBTO in which GDPS centres have to play a role as far as atmospheric detection techniques are concerned;

(*i*) Enrourage links between WMO and UNEP in order to specify products and procedures to be established for chemical incidents that would provide the best response in a coordinated way and, as needed, encourage and coordinate the implementation in the GDPS centres of procedures to be activated to support a response to chemical incidents;

(*j*) Better define meteorological support and services which can be provided by GDPS centres to the United Nations and related agencies dealing with humanitarian missions and to strengthen the links between WMO and UN/OCHA in order to specify the products and procedures to be established for giving the best response in a coordinated way;

Year 2000 problem

(*k*) Advise on the year 2000 problems related to operational data-processing and forecasting systems;

General tasks

(*l*) Advise on relevant training material, seminars and workshops;

(*m*) Update relevant regulatory and guidance material.

FUTURE WORK PROGRAMME — OPAG ON PUBLIC WEATHER SERVICES

Product development

(*a*) Investigate, understand and document with the other relevant OPAGs, the particular technical requirements of data and products to support the PWS Programme;

(*b*) Develop guidelines and training material for developing countries on graphical presentation (design, contents, etc.) and modules of graphical educational material;

PWS practices, coordination and training

(*c*) Complete the preparation and publication of the expanded *Guide to Public Weather Services Practices* (WMO-No. 834);

(*d*) Complete the evaluation and the analysis of the questionnaire on PWS and publish the results;

(*e*) Establish a mechanism for dealing promptly with issues of consistency between official warnings and information disseminated by the international media;

(*f*) Investigate the formal and informal relationships which NMHSs have established with emergency management organizations and develop guidelines for a best practice;

(*g*) Provide guidance on establishing a mechanism for ongoing dialogue between NMHSs and both national and international media agencies;

(*h*) Advise on roving seminars and create syllabi for national PWS training programmes based on WMO training programmes for RMTCs;

(*i*) Contribute to the preparation and delivery of at least one seminar/workshop in each Region on methods of working with the Government, media, and key recipients of public weather services to enhance the visibility of the NMHSs;

(*j*) Contribute to the preparation and delivery of at least one seminar/workshop in each Region on methods of improving public weather products and services to meet user requirements;

(*k*) Develop a methodology for the international exchange of NMHS forecasts for the public as part of the efforts to enhance visibility of NMHS;

(*l*) Develop a methodology for cross-border exchange of warnings;

Verification process

(*m*) Prepare recommendations on standardized verification techniques for public warnings and forecasts;

(*n*) Prepare guidelines on technical and user-oriented verification mechanisms including measures of overall satisfaction with the service.

APPENDIX A

LIST OF PERSONS ATTENDING THE SESSION

A. OFFICERS OF THE SESSION

S. Mildner	President
G. Love	Vice-president

B. REPRESENTATIVES OF WMO MEMBERS

Member	*Name*	*Capacity*
Argentina	M. A. Rabiolo	Principal delegate
Australia	G. Love	Principal delegate
	T. Hart	Alternate
Austria	H. Gmoser	Principal delegate
	K. Panosch	Delegate
Belgium	A. Quinet	Principal delegate
Belize	C. Fuller	Principal delegate
Botswana	D. F. Molotsi	Principal delegate
	W. Minja	Alternate
Brazil	J. M. de Rezende	Principal delegate
Brunei Darussalam	H. S. H. Sirabaha	Principal delegate
	A. L. H. Abdullah	Delegate
Bulgaria	M. N. Popova-Sapareva (Ms)	Principal delegate
Cameroon	M. Mbiengwen	Principal delegate
	E. G. Ondoua	Alternate
Canada	A. Kellie	Principal delegate
	A. Simard (Ms)	Alternate
	B. Greer	Delegate
	B. Angle	Advisor
China	Yan Hong	Principal delegate
	Qiu Guoqing	Delegate
	Xu Xiaofeng	Delegate
	Deng Yong	Delegate
Côte d'Ivoire	A. Kignaman-Soro	Principal delegate
Croatia	K. Pandzic	Delegate
Czech Republic	E. Cervená (Ms)	Principal delegate
Denmark	E. Bødtker (30.9–2.10.98)	Principal delegate
	N. J. Pedersen (3–9.10.98)	Principal delegate
Egypt	A. E. Amer	Principal delegate
	M. S. Hammad	Alternate
Fiji	R. Prasad	Principal delegate
Finland	J. Riissanen	Principal delegate
France	D. Lambergeon	Principal delegate
	J.-P. Bourdette	Delegate
	M. Fischer	Delegate
Georgia	N. Beradze	Principal delegate
	R. B. Chitanaval	Delegate
Germany	S. Mildner	Principal delegate
	G. Steinhorst	Delegate
	G-R. Hoffmann	Delegate
	M. Kurz	Delegate
	W. Kusch	Delegate
	V. Vent-Schmidt	Delegate
	M. Engels	Delegate
Greece	G. Sakellaridis	Principal delegate
Hong Kong, China	H. G. Wai	Principal delegate
Hungary	I. Mersich	Principal delegate
	T. Prager	Alternate
	M. B. Sallai (Ms)	Delegate
Iceland	G. Hafsteinsson	Principal delegate
Ireland	M. R. Walsh	Principal delegate
Italy	C. de Simone	Principal delegate
Japan	T. Hiraki	Principal delegate
	K. Kashiwagi	Delegate
Kenya	E. A. Mukolwe	Principal delegate
	K. I. Essendi	Alternate
Latvia	A. Leitas	Principal delegate
Macao	A. Viseu	Principal delegate
Mongolia	D. Tseesodroltsoo	Principal delegate
	D. Jugder (Ms)	Delegate
Netherlands	H. Daan	Principal delegate
	J. P. van der Meulen	Delegate
	D. J. van der Duyn Schouten	Delegate
New Zealand	N. Gordon	Principal delegate
Nigeria	T. Obidike	Principal delegate
Norway	K. A. Bjørheim	Principal delegate
	J. Sunde	Alternate
Oman	A. H. M. Al-Harthy	Principal delegate
Poland	J. Zielinski	Principal delegate
	F. Marczak	Advisor
Portugal	M. J. Zorro Gonçalves	Principal delegate
	M. J. Rodrigues Almeida	Delegate
Qatar	R. G. Al-Kubaisi	Principal delegate
Republic of Korea	K.-S. Shin	Principal delegate
Romania	E. Cordoneanu (Ms)	Principal delegate
Russian Federation	V. Dyadyuchenko	Principal delegate
	A. Gusev	Alternate
Senegal	S. Diallo	Principal delegate
Slovakia	M. Ondrás	Principal delegate

Member	*Name*	*Capacity*
South Africa	K. E. Estié	Principal delegate
Spain	C. Callejas	Principal delegate
Sweden	K. Hagström S. Nilsson	Principal delegate Alternate
Switzerland	P. Rauh H. P. Roesli	Principal delegate Delegate
Syrian Arab Republic	S. Jabbour M. Soleiman	Principal delegate Alternate
The former Yugoslav Republic of Macedonia	R. Gareva (Ms)	Principal delegate
Uganda	E. Bazira	Principal delegate
United Arab Emirates	A. N. A. Akkeen	Principal delegate
United Kingdom of Great Britain and Northern Ireland	C. Flood M. Atkins (Ms) A. McIlveen J. Caughey J. Nash	Principal delegate Delegate Delegate Delegate Observer
United Republic of Tanzania	P. A. Mwingira	Principal delegate
United States of America	J. Jones M. Yerg F. Zbar J. Fenix	Principal delegate Alternate Delegate Advisor
Uzbekistan	G. Rahman-Zada	Principal delegate
Venezuela	A. W. Goldbrunner	Principal delegate

C. Invited experts

E. A. Mukolwe	**Chairperson, RA I Working Group on Planning and Implementation of the WWW**
K. Prasad	**Chairperson, RA II Working Group on Planning and Implementation of the WWW**
M. A. Rabiolo	**Chairperson, RA III Working Group on Planning and Implementation of the WWW**
C. Fuller	**Chairperson, RA IV Working Group on Planning and Implementation of the WWW**
R. Brook	**Chairperson, RA V Working Group on Planning and Implementation of the WWW**
M. Kurz	**Chairperson, RA VI Working Group on Planning and Implementation of the WWW**
Z. Mumba	**African Centre of Meteorological Applications for Development (ACMAD)**
S. K. Srivastava	**President, Commission for Instruments and Methods of Observation (CIMO)**
M. Manton	**Chairperson, GCOS/WCRP Atmospheric Observation Panel for Climate**

D. Representatives of international organizations

Organization	*Name*
Agency for Air Safety in Africa and Madagascar (ASECNA)	M. Sissako
European Centre for Medium-range Weather Forecasts (ECMWF)	M. Capaldo
European Meteorological Network (EUMETNET)	C. Pastre
European Organization for the Exploitation of Meteorological Satellites (EUMETSAT)	T. Mohr P. Counet
European Space Agency (ESA)	P. Ingmann
International Association of Broadcast Meteorology (IABM)	I. Niedek (Ms) G. Fleming
International Civil Aviation Organization (ICAO)	O. Turpeinen

APPENDIX B

AGENDA

	Agenda item	*Documents*	*Resolutions and recommendations adopted*
1.	OPENING OF THE SESSION	PINK 1	
2.	ORGANIZATION OF THE SESSION	PINK 1	
2.1	Consideration of the report on credentials		
2.2	Adoption of the agenda	1; 2	
2.3	Establishment of committees		
2.4	Other organizational questions		
3.	REPORT BY THE PRESIDENT OF THE COMMISSION	3; 11; PINK 2; PINK 16	Res. 1
4.	WORLD WEATHER WATCH (WWW) COMPONENTS AND SUPPORT FUNCTIONS, INCLUDING REPORTS BY THE CHAIRPERSONS OF WORKING GROUPS		
4.1	Global Observing System (GOS)	16; 20; PINK 15	Rec. 1
4.2	Global Telecommunication System (GTS)	15; 15, ADD. 1; 18; PINK 3	Rec. 2
4.3	Global Data-processing System (GDPS)	17; 17, ADD. 1; 21; 24; 26; PINK 5; PINK 6; PINK 7; PINK 8; PINK 19	Rec. 3; 4
4.4	World Weather Watch (WWW) Data Management (DM)	4; 4, ADD. 1; 12; 12, ADD. 1; 13; 14; 14, ADD. 1; 14, ADD. 2; 14, ADD. 3; 22; 23; PINK 10; PINK 10, CORR. 1; PINK 17; PINK 20	Rec. 5; 6
4.5	WMO satellite activities	7; PINK 4	
4.6	Operational Information Service (OIS)	6; PINK 14	
4.7	Public Weather Services (PWS)	9; 9, ADD. 1; PINK 21	
5.	DEMONSTRATION OF REGIONAL SPECIALIZED METEOROLOGICAL CENTRE (RSMC) CAPABILITIES	25; PINK 9	
6.	LONG-TERM PLANS		
6.1	Monitoring and evaluation of the Third (3LTP) and Fourth WMO Long-term Plans (4LTP)	10; PINK 11	
6.2	Preparation of the Fifth WMO Long-term Plan (5LTP)	19; PINK 12	
7.	STRUCTURE OF THE COMMISSION FOR BASIC SYSTEM (CBS)	5; PINK 18	Res. 2; 3; 4
8.	COMMISSION FOR BASIC SYSTEMS (CBS) WORK PROGRAMME; ESTABLISHMENT OF WORKING GROUPS AND RAPPORTEURS	PINK 22	
9.	REVIEW OF PREVIOUS RESOLUTIONS AND RECOMMENDATIONS OF THE COMMISSION AND RELEVANT EXECUTIVE COUNCIL RESOLUTIONS	8; PINK 13	Res. 5; Rec. 7
10.	DATE AND PLACE OF THE TWELFTH SESSION	PINK 23	
11.	CLOSURE OF THE SESSION	PINK 23	

APPENDIX C

LIST OF DOCUMENTS

Doc. No.	*Title*	*Agenda item*	*Submitted by*
	I. "DOC" series		
1	Provisional agenda	2.2	–
2	Explanatory memorandum relating to the provisional agenda	2.2	–
3	Report of the president of the Commission	3	President of CBS
4	World Weather Watch (WWW) Data Management (DM) Report of the Commission for Basic Systems Task Group on the Internet ADD. 1	4.4	Chairperson, Task Group
5	Structure of the Commission for Basic Systems (CBS)	7	President of CBS
6	Operational Information Service (OIS)	4.6	Secretary-General
7	WMO satellite activities Report of the third session of the Commission for Basic Systems Working Group on Satellites	4.5	Chairperson, Working Group
8	Review of previous resolutions and recommendations of the Commission and relevant Executive Council resolutions	9	Secretary-General
9	Public Weather Services (PWS) ADD. 1	4.7	Chairperson, Working Group
10	Monitoring and evaluation of the Third (3LTP) and Fourth WMO Long-term Plans (4LTP)	6.1	Secretary-General
11	Report by the president of the Commission Participation of women in the work of the Commission	3	President of CBS
12	World Weather Watch (WWW) Data Management (DM) Report of the chairperson of the Working Group on Data Management ADD. 1	4.4	Chairperson, Working Group
13	World Weather Watch (WWW) Data Management (DM) The year 2000 problem	4.4	Secretary-General
14	World Weather Watch (WWW) Data Management (DM) Data representation and codes ADD. 1 ADD. 2 ADD. 3	4.4	Secretary-General

Doc. No.	*Title*	*Agenda item*	*Submitted by*
15	Global Telecommunication System (GTS)	4.2	Chairperson, Working Group
	ADD. 1		
16	Global Observing System (GOS)	4.1	Secretary-General
	Recent activities of the Global Climate Observing System (GCOS)		
17	Global Data-processing System (GDPS)	4.3	Chairperson, Working Group
	World Weather Watch (WWW) components and support functions, including reports by the chairpersons of the working groups		
	ADD. 1		
18	Global Telecommunication System (GTS)	4.2	Secretary-General
	Radio frequencies for meteorological activities		
19	Preparation of the Fifth WMO Long-term Plan (5LTP)	6.2	Secretary-General
20	Global Observing System (GOS)	4.1	Chairperson, Working Group
21	Global Data-processing System (GDPS)	4.3	Secretary-General
	Status of the World Weather Research Programme (WWRP)		
22	World Weather Watch (WWW) Data Management (DM)	4.4	President of CIMO and the Secretary-General
	Automation of visual and subjective observations		
23	World Weather Watch (WWW) Data Management (DM)	4.4	Germany
24	Global Data-processing System (GDPS)	4.3	Secretary-General and the president of CCl
	Infrastructure needs for seasonal to interannual climate prediction		
25	Demonstration of Regional Specialized Meteorological Centre (RSMC) capabilities	5	Fiji
26	Global Data-processing System (GDPS)	4.3	United Kingdom
	The role of workstations in the national Meteorological and Hydrological Services (NMHSs)		
	II. "PINK" series		
1	Opening of the session	1 and 2	President of CBS
	Organization of the session		
2	Report by the president of the Commission	3	President of CBS
3	Global Telecommunication System (GTS)	4.2	Chairperson, Working Committee

Doc. No.	*Title*	*Agenda item*	*Submitted by*
4	WMO satellite activities	4.5	Chairperson, Working Committee
5	Global Data-processing System (GDPS) World Weather Watch (WWW) components and support functions, including reports by the chairperson of the working groups	4.3	Chairperson, Working Committee
6	Global Data-processing System (GDPS) Infrastructure needs for seasonal to interannual climate prediction	4.3	Chairperson, Working Committee
7	Global Data-processing System (GDPS) Status of the World Weather Research Programme (WWRP)	4.3	Chairperson, Working Committee
8	Global Data-processing System (GDPS) The role of workstations in the national Meteorological and Hydrological Services (NMHSs)	4.3	Chairperson, Working Committee
9	Demonstration of Regional Specialized Meteorological Centre (RSMC) capabilities	5	Chairperson, Working Committee
10	World Weather Watch (WWW) Data Management (DM) Data representation and codes CORR. 1	4.4	Chairperson, Working Committee
11	Monitoring and evaluation of the Third (3LTP) and Fourth WMO Long-term Plans (4LTP)	6.1	Vice-president of CBS
12	Preparation of the Fifth WMO Long-term Plan (5LTP)	6.2	Vice-president of CBS
13	Review of previous resolutions and recommendations of the Commission and relevant Executive Council resolutions	9	Chairperson, Working Committee
14	Operational Information Service (OIS)	4.6	Chairperson, Working Committee
15	Global Observing System (GOS)	4.1	Chairperson, Working Committee
16	Report by the president of the Commission Participation of women in the work of the Commission	3	President of CBS
17	World Weather Watch (WWW) Data Management (DM) The year 2000 problem	4.4	Chairperson, Working Committee
18	Structure of the Commission for Basic Systems (CBS)	7	Vice-president of CBS
19	Global Data-processing System (GDPS)	4.3	Chairperson, Working Committee

Doc. No.	*Title*	*Agenda item*	*Submitted by*
20	World Weather Watch (WWW) Data Management (DM)	4.4	Chairperson, Working Committee
21	Public Weather Services (PWS)	4.7	Chairperson, Working Committee
22	Commission for Basic Systems (CBS) work programme; establishment of working groups and rapporteurs	8	Vice-president of CBS
23	Date and place of the twelfth session	10 and 11	President of CBS
	Closure of the session		